2007

BAT USE OF CONIFEROUS FORESTS AT MESA VERDE NATIONAL PARK: YEAR 1 PROGRESS REPORT

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I. Executive Summary

This report provides results and a summary of progress from the first summer field season (2006) of the study "Bat Use of the Coniferous Forests at Mesa Verde National Park." This study is being conducted by the Fort Collins Science Center of the U.S. Geological Survey under the Natural Resources Preservation Program, working in cooperation with the independently funded graduate research project of E.A. Snider, Colorado State University. Results from the Snider project are not summarized in this report. Our principal objectives were (1) to compile, review, and synthesize available information on the occurrence, status, roosting habits, and natural history of bats at and around Mesa Verde (MEVE); (2) to identify water sources in piñon-juniper woodlands at MEVE where bats can be mist netted: (3) to capture bats at these sites and then to characterize the species composition, relative abundance, and sex and reproductive characteristics of the MEVE bat fauna; (4) to tag individuals with miniaturized radio transmitters, and follow them to determine locations and characteristics of their roosts; and (5) to assess the feasibility of using echolocation activity to augment species occurrence information and to determine possible use of habitats with different fire histories by foraging bats.

We sampled bats in mist nets set near three sewage lagoons and less frequently at five other sites on 58 nights from 17 May to 23 August 2006. We captured 913 bats at these sites, documenting 15 species of bats through capture and identifying the presence of a 16th species through recordings of vocalizations. Mesa Verde is used by all species of bats known in Colorado west of the Front Range. We documented two species previously never captured at Mesa Verde (spotted bat, *Euderma maculatum*, and Yuma myotis, *Myotis yumanensis*) and one not documented at Mesa Verde for

over 40 years (canyon bat, *Parastrellus hesperus*). The fauna was characterized by one abundant species (long-legged myotis, *Myotis volans*), five moderately common species (long-eared myotis, *Myotis evotis*; silver-haired bat, *Lasionycteris noctivagans*; big brown bat, *Eptesicus fuscus*; western small-footed myotis, *Myotis ciliolabrum*; and occult myotis, *Myotis occultus*), and nine species that each represented less than 3 percent of total captures. Review of the regional faunal literature shows that the six most abundant species of bats at Mesa Verde are commonly reported to inhabit mid-elevation forested sites in the Rocky Mountains and Southwestern States. Seven of the nine less common species can be categorized as bats that are either (1) chiefly inhabitants of lower elevation, warmer and more arid zones than those sampled; or (2) are bats that may be typical of the zones in which we sampled but often fly high above ground or are very maneuverable and adept at avoiding nets, habits that make them less likely to be captured. The remaining two species consist of one that is highly migratory (hoary bat, *Lasiurus cinereus*) and apparently not commonly captured outside of migration in Colorado, and one (fringed myotis, *Myotis thysanodes*) that is typical of the areas we sampled but apparently uncommon. In addition to bats captured in hand, we also heard and recorded calls of the big free-tailed bat (*Nyctinomops macrotis*). Five of the fifteen species of bats we captured at Mesa Verde had sex ratios very highly skewed towards males, and most of these specimens showed no evidence for reproduction at Mesa Verde. This skewed distribution is not unexpected for these species. Adult sex ratios of a few other species also seemed to favor males. Females were numerically dominant over males in the most abundant species, long-legged myotis, and clearly used the mesa tops during reproduction. We captured 310 adult long-legged myotis, and 240 of these adults were females. Our capture records indicate that the occult myotis leave Mesa Verde for the period from late June to early August, when they form maternity colonies at warmer sites in lower elevations (also verified by radiotracking). We obtained evidence for reproduction in females of 10 species of bats at Mesa Verde. The general period when birth and lactation take place seems to be from late June to about the fourth week of July. Adult females of several species that breed at Mesa Verde showed seemingly low reproductive rates in 2006, and the data suggest that, except for two species, reproductive females seem to favor areas lower in elevation than the places we commonly netted (few netting sites occur at low elevations within the park and access to these sites for sampling is difficult). The very low abundance of juveniles of all species at all netting sites suggests that young bats also were not foraging at the higher elevations typical of most of our netting sites at Mesa Verde. Netting success was low in August at Mesa Verde due to unknown biases.

We provide details on records of 189 specimens of bats taken at Mesa Verde National Park and held at the Museum of Southwestern Biology. We also document an additional 101 specimens housed elsewhere and other records (audible observations or bats captured and released) of bats from Mesa Verde or nearby localities in Montezuma, Dolores, or LaPlata Counties, Colo. Published accounts of the bat fauna appear in three scientific publications (Anderson, 1961; Douglas, 1967; and Chung-MacCoubrey and Bogan, 2003), which encompass most of the specimens. Unlike our netting survey, none of the records that we obtained from museum databases, other publications, or unpublished sources added to the list of species documented in these three publications. This past work documented the presence of 13 species of bats at Mesa Verde and nearby locales. The most intensive past survey (1989–1994) was based on a smaller number of bats captured than in 2006, sampled at somewhat different times of the year, and captured bats over smaller pools that did not exist in 2006. These differences in conditions make results between the two studies difficult to compare. The long-eared and long-legged myotis were the two most frequently captured species in both surveys, but they differed in ranks in the two studies. Relative abundances of other species also differed, but the 1989–1994 surveys generally sampled over smaller pools. Smaller pools may not be frequented as often by the less agile, faster flying species that were more abundant at the large, open sewage lagoons sampled in the 2006 surveys. Differences in relative abundance were not marked when comparisons were limited to a single canyon (Morefield) adequately sampled in both surveys. Overall, the evidence for reproduction, presence of juveniles, and sex ratios were comparable between the two studies. Long-eared myotis may be an exception, with a greater preponderance of males and perhaps lowered reproduction in 2006 than in the earlier study. We observed and sampled ectoparasites and sampled fresh guano pellets for viral analysis as time permitted during handling of bats for the parkwide survey. Approximately 82 ectoparasites were retrieved from 41 bats. Totals for larger ectoparasites include: 10 fleas, 21 bat flies, 4 bat/bed bugs, 5 ticks, and 5 wing mites. Ectoparasites collected in 2006 were removed from 13 species of bat. Fresh fecal pellets were collected from 21 bats captured at sewage lagoons during the surveys on August 14–20. Evidence for coronavirus was found in feces of five occult myotis and one big brown bat. There were at least two distinct coronaviruses in the sample, both of which are new to science and are the first evidence for coronoaviruses in New World bats. Coronaviruses are expected to be widespread and common throughout bats of the world but have not been widely surveyed.

The 16 species of bats at Mesa Verde are a species-rich fauna in an area characterized primarily by piñon-juniper woodlands. Species richness is higher than in the most comparable study of bats in this forest type, conducted in the piñon-juniper woodlands of the Gallinas Mountains of New Mexico. We suspect that the difference in species richness between the two bat faunas is primarily the availability at Mesa Verde of rock crevices in cliffs and canyon walls as potential roosting sites. Topographic diversity with cliffs and a variety of configurations of possible roosting structures is known from the literature to be a correlate of bat diversity. The high mesas bisected by numerous canyons and cliff faces provide very favorable roosting habitat for bats. It is our opinion that this feature overrides any extensive reliance by bats on piñon or juniper trees and snags as roosts. Our findings regarding sex ratios and reproduction in the Mesa Verde bat community, however, suggest the hypothesis that the upper reaches of canyons and mesa tops where most netting took place may be at elevations that are too high and cool to be favorable for reproduction by some species of bats.

We tagged 36 bats of 7 different species with radio transmitters. Most (78 percent) belonged to three species: long-eared myotis, long-legged myotis, and occult myotis. We tagged three or fewer individuals of the fringed myotis, Yuma myotis, Townsend's big-eared bat, and spotted bat. We were most successful in finding the general roost locations of spotted bats (100 percent; n=3), occult myotis (80 percent; n=4), long-legged myotis (63 percent; n=6), and long-eared myotis (43 percent; n=6). We emphasized tagging pregnant and lactating bats so that we could locate maternity colonies. We were unable to find the daytime roosts of the Yuma myotis or Townsend's big-eared bats that we tagged. We detected the signal of one of the fringed myotis but were unable to localize it. We suspect that many of the bats we did not find were roosting within rock (crevices or caves) in remote areas of the park that were more than 1–2 km from access roads, the approximate distance at which we regularly detected bats in such roosts. In general, long-eared myotis switched roosts frequently, with an average of 4.6 roosts discovered per bat followed. Other species switched roosts less frequently, with ≤ 2 roosts found or suspected per bat. Roosts of long-eared myotis were found throughout the study area. Roosts of occult myotis were found in Morefield Canyon and in the Mancos River Valley. Roosts of long-legged myotis were mostly found in steep-walled canyons on the southern end of the park, as were those of spotted bats. We were able to determine the precise location of one of the roosts used by spotted bats in the Echo Cliff on the south end of the park. This roost is the first known colony of spotted bats in Colorado. Reproductive female bats were found roosting in all parts of the study area, with perhaps a slight trend toward pregnant females roosting at lower elevations in the Mancos Valley (occult myotis) and on the southern end of the park (long-legged myotis and spotted bats). We found bats roosting in a variety of structures. Long-legged myotis and spotted bats roosted exclusively in rock crevices within steep canyon slopes and cliff faces. All but one of the female occult myotis that we tagged were found roosting in buildings in the Mancos Valley. One female long-eared myotis tagged in mid-June at the sewage lagoon in Morefield Canyon was found on Bureau of Land Management (BLM) land north of the park, roosting in juniper snags, downed logs, and live trees. All (n=5) of the other female long-eared myotis that we followed were found roosting in rock crevices, often close to the ground. Radiotagged bats regularly traveled more than 10 km between their capture site and subsequent roosts. We were better able to access roost sites used by long-eared myotis and occult myotis than by other species because they were usually in rock crevices near the ground or in buildings, respectively. We had a harder time pinpointing roosts used by long-legged myotis and spotted bats because these species tended to roost in more inaccessible, steep-walled canyons near the southern end of the park. Many species of bats in western North America rely on rock crevices as roosting sites, but the extent of use and requisite characteristics of such sites are poorly understood. In our study, we found three species of bats (long-eared myotis, long-legged myotis, and spotted bats) roosting mostly in rock crevices. Researchers working in other regions have also noted the predominant use of rock crevices by long-eared myotis and spotted bats. However, our findings of the extensive use of rock crevices by long-legged myotis differ from the results of most of the other studies on this species. Little is known about the roosting preferences of bats when both trees and rock crevices are available in a landscape, but our results from Mesa Verde indicate that use of trees may be limited when rock crevice roosts are an abundant resource. Results of trials using scent-trained dogs also failed to provide evidence of major use of trees as roosts by bats at Mesa Verde. Bats generally tend to show greater fidelity to roosts that are more permanent than to those that are more temporary; thus they may prefer the more stable roost structures in rock to trees. However, the sample of long-legged myotis that we tracked during 2006 was small, and additional data are needed concerning this species before conclusions can be drawn. If bats are using piñon and juniper trees as roosts at Mesa Verde, then the long-legged myotis is the most likely bat to do so.

We began to develop a reference library of echolocation calls of bats at Mesa Verde by recording vocalizations from bats captured with mist-nets near water sources. Recordings were made using an Anabat II detector interfaced with an IBM-compatible laptop computer. We recorded the calls of eight species of bats during 49 hand releases and made additional recordings of free-flying Brazilian free-tailed bats and canyon bats. We also randomly selected two sites in intact piñon-juniper forest and two sites in burned piñon-juniper forest on Chapin Mesa using a Geographic Information System. We passively monitored bat calls at each station using Anabat II bat detectors connected to programmable zero-crossings analysis interface modules. We monitored activity levels of bats for 10 nights each in June, July, and August at the four stations, timing the samplings to occur at the same phases of the moon each month. Calls were identified to species based on qualitative and quantitative parameters from known call libraries. A total of 15,389 unique files were collected during June, July, and August from all stations combined. We quantified the number of bat passes (≥ call pulses) within these files and identified 12,888 of them to species or species groups (83.7 percent). Sixteen species were identified and the largest number of bat passes were attributed to Brazilian free-tailed bats (3,143 passes), followed by the big brown bat/silver-haired bat group (2,779 passes), canyon bats (291 passes), and small-footed myotis (146 passes). More low frequency bat passes were collected at burned locations than at intact locations. More passes of *Myotis* sp. were collected from intact locations than from burned locations. All species captured using mist nets were detected at acoustic monitoring stations. Additionally, we collected calls from big free-tailed bats with acoustic monitoring. There was generally more bat activity (total number of bat passes, all species) collected per night in burned locations than in intact locations. Activity also varied by date and month. Similarly, there were more foraging attempts or feeding buzzes collected per night in burned locations, but evidence of foraging activity was low for all stations in both treatments. Average activity during June at all stations and treatments was significantly higher than during July and August. However, activity among sites was variable due to night-to-night differences and correspondingly has large standard deviations. More foraging attempts were recorded in June as well, but the average number of feeding calls detected did not differ significantly from July and August sampling periods. The models selected with Akaike's Information Criterion corrected for sample size AICc that parsimoniously explained most of the variation in activity of low frequency and 40 kHz *Myotis* groups were those that included Station (four sites), Date (within a month), and Month (Passes ~ Station + Date + Month). All other models were more than 1,307.3 ΔAICc values from the top model. Station location, month, and date explained more of the variability in activity levels than treatment (burned or intact) alone. Our results indicate that habitat use and echolocation activity by bats in burned and intact piñon-juniper forests differs with more activity in burned than in intact sites, but we cannot quantitatively attribute the differences to the effects of fire. Variability in numbers of bat passes for both low frequency bats and species within the 40 kHz *Myotis* sp. group was best explained by temporal patterns and by station (point), but not by treatment (fire). The least supported model was one that included treatment (fire) only. Both bat activity and foraging attempts were highest at burned locations and during the month of June. However, foraging activity was very low in all four locations indicating that piñon-juniper forests on Chapin Mesa may be used mostly by commuting bats rather than by foraging bats. Bat activity and foraging was highest at Station C in the burned habitat, which may be a result of its proximity to the rim of Soda Canyon, where bats probably roosted in crevices in canyon walls.

We recommend that in 2007 the project should continue to capture bats in mist nets to sample for species composition, age, and sex of bats at Mesa Verde. Records from 2006 have generated a series of related hypotheses that can be subject to statistical analyses based on an additional summer of sampling. These hypotheses are (1) that sex biases occur in abundance of some common species, and (2) that elevation may account for some of these differences. The higher elevations associated with the northern parts of Mesa Verde, where much of our netting takes place, may be marginal habitat for reproduction in females of some species. A fuller investigation of this hypothesis calls for increased sampling at sites at lower elevations near and within

Mesa Verde during the maternity period. The project should also continue to determine reproductive status of adult female bats. This information will allow the comparison of reproductive rates within species between the sampling years, allowing us to determine if rates are generally low and thus consistent with a hypothesis of marginal habitat quality for reproduction at higher elevations in Mesa Verde. The survey of bats should also continue to sample bats for ectoparasites and coronaviruses opportunistically, and sampling of fecal pellets for the viruses should be expanded to include swabbing the rectal area of individual bats. Radiotelemetry studies in 2007 should attempt to improve efficiency by employing an aircraft to find the initial locations of tagged bats. It is likely that many of the bats we tagged but did not find during 2006 remained in the park in deep canyons that we could not monitor easily from roads. Use of an aircraft should then be followed by surveys on foot to better pinpoint locations and estimate colony size. These efforts should be made during the late June to mid-July period of peak female reproduction to maximize chances of finding maternity colonies. Spotted bats should continue to be tagged and followed during 2007. Long-eared myotis and long-legged myotis should also continue to be tracked to establish the possible use of trees as roosts at Mesa Verde. Additional data are needed to rule out the possibility that long-legged myotis take advantage of old growth piñon and juniper trees in addition to rock crevices for roosts at Mesa Verde. We recommend that echolocation detector work focus exclusively on obtaining more recordings of calls of known species through hand releases during netting captures. These recordings can be provided as a reference call library for the park in support of the past and future recording efforts carried out by natural resources staff independent of our efforts. We recommend that the fixed monitoring station recording should be discontinued because of high variability in the sampling and insufficient equipment to determine effects of past burns, particularly on foraging activity.

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II. Introduction and Objectives

By Thomas J. O’Shea, Paul M. Cryan, Laura E. Ellison, and Ernest W. Valdez

This report provides results from the first summer field season of the study "Bat Use of the Coniferous Forests at Mesa Verde National Park." This study is being conducted by our team of four biologists from the Fort Collins Science Center (including both Fort Collins headquarters and the Albuquerque field station) under the U.S. Geological Survey's component of the Natural Resources Preservation Program at the request of Mesa Verde National Park (18 Project 83279NA or NRPP-06-08 [25]). We are also working cooperatively with E. Apple Snider, a graduate student from the Department of Fish, Wildlife, and Conservation Biology at Colorado State University. Snider is conducting intensive research on the insect community at Mesa Verde in relation to the feeding habits of selected species of bats and to fire history, and is also making detailed characterizations of roosting habitat selection for the long-eared myotis (*Myotis evotis*). Her results will be reported elsewhere.

There were seven objectives of this study described in the original U.S. Geological Survey task plan: (1) compile, review, and synthesize available information on the occurrence, status, roosting habits, and natural history of bats at and around MEVE; (2) identify water sources in piñon-juniper woodlands at MEVE where bats can be mist netted, and use these sites for assessing species occurrence as well as to obtain bats for radio-tagging;(3) capture bats at MEVE, equip selected individuals with miniaturized radio transmitters, and release them unharmed; (4) follow radio-tagged bats to their roosts and obtain data on emergence flights, species composition, nearby roosts, roost tree characteristics, and tree stand characteristics; (5) assess the feasibility of using echolocation activity to augment species occurrence information, and to determine possible use of habitats with different fire histories by foraging bats; (6) compile, analyze, and synthesize all data gathered; and (7) provide a final report on the project, including park-specific recommendations on managing forest stands for conserving bats.

This report describes progress towards meeting objectives 1–6 in three separate sections, and each section includes recommendations for the upcoming second field season in summer 2007. In Section III we describe results from objectives 1–3 to date, which center on describing the bat fauna at Mesa Verde through capture, identification, and release of bats using mist-nets at watering areas. Section IV provides a summary of activities related to radiotracking of bats to roosts (objective 4), and Section V presents results of echolocation activity sampling (objective 5). The report also includes progress under objective 6 within each section. The level of statistical analyses from this first field season is very limited, with one exception. This limitation occurred because tests of hypotheses could not be formulated until some basic results were obtained in year one, and also because such analyses would be incomplete, given that the study awaits a second year of data collection. The one exception to this limitation is the echolocation activity monitoring (Section V), which we carried out in part to assess the feasibility of using this technique to determine if there is differential use of habitats with different fire histories by foraging bats. We also include two additional short sections that cover efforts that developed as we were conducting the study. Section VI summarizes a pilot study conducted in collaboration with a U.S. Forest Service research biologist to determine the efficacy of using specialized scent-detecting dogs to locate bat roosts in trees at Mesa Verde, and Section VII provides a summary of other wildlife-related field observation made over the course of summer 2006. Photographs illustrating some of our activities are given in appendix II.

III. The Bat Fauna at Mesa Verde National Park

By Thomas J. O'Shea and Ernest W. Valdez

Introduction

We conducted a survey of the bat fauna at Mesa Verde National Park from May through August 2006. We also searched for past records and publications on the bats of Mesa Verde. In this section we report the species composition of the bat community at Mesa Verde, describe patterns in abundance and reproduction in these bats, and compare our results with past information gathered prior to the prolonged droughts and intense fires of the past decade (more than 15,000 hectares of Mesa Verde forests have burned since 1996; Floyd and others, 2003). The bat survey also provides the backdrop against which we conducted other phases of research on bat use of the coniferous forests at Mesa Verde, particularly radiotracking of bats to roosts (see Cryan, Section IV, this report) and determination of patterns in echolocation activity of bats at burned and intact sites (see Ellison, Section V, this report). This section of the first-year progress report provides a compilation of results based on the sampling, identification, and assessment of sex and reproductive condition of bats captured in mist nets set near watering sites. Further, it provides a summary of past records of bats in or near Mesa Verde, and also makes qualitative comparisons and generates descriptive hypotheses for testing during the 2007 field season. Thus results in this section do not include statistical tests of hypotheses. Such analyses are premature at this stage of the study, particularly without *a priori* hypotheses. However, most of the data provided in the report and related tables and appendices are sufficient for an interested reader to conduct their own analyses should they desire. More detailed analyses of the data will be carried out after the 2007 field season, which should include sampling to test some of the hypotheses generated in this report. Additional recommendations for 2007 research are also made based on this summary of progress. Similarly, this report is not intended to include a detailed literature review of the ecology of those species of bats we documented at Mesa Verde. However, we tie some of our findings to the literature where appropriate and include some general background information below to help place our survey activities in the context of the natural history of western bats.

In this section we provide results that are attempts to answer some of the following questions: What species of bats occur at Mesa Verde? How does the bat community in 2006 compare with the species composition known previously for Mesa Verde? Are there differences in sex ratios and relative abundance of different species of bats at Mesa Verde, and do these differences show patterns by elevation, season, or obvious habitat features? Is Mesa Verde important as habitat for reproduction in bats, which species reproduce at the park, and does reproduction vary by elevation in certain species? Is there evidence for change in any of these patterns of reproduction, sex ratios, or relative abundances of species and sexes within species between the 2006 survey and past records?

Background Information on the Natural History of Western Bats

Although the number of species of bats in the Western United States is well known, there have been few intensive surveys of the bat fauna within specific land management areas and landscapes. Details on species composition of local bat communities, seasonal occurrences, patterns of reproduction, feeding ecology, roosting habits, and other aspects of bat ecology are typically lacking for many specific areas. Similarly, even fewer areas have been studied intermittently over time scales greater than a few years to attempt to judge changes in such properties of bat communities in relation to other environmental changes.

There are several reasons for this lack of knowledge. Despite a great deal of interest in the status of bats in the Western United States, they continue to be notoriously difficult to survey or census. This difficulty is due in part to their nocturnality, secretive daytime habits, and considerable mobility. In addition, specialists are required to undertake bat surveys because species identifications sometimes call for discrimination of subtleties in external morphological characters, and for several groups the taxonomy continues to be refined as we learn more about each species. For example, systematics of three of the species of bats known from Mesa Verde in the last survey ending in 1994 (Chung-MacCoubrey and Bogan, 2003) have since been revised and now have different scientific binomial names, including two different generic designations (Bogdanowicz and others, 1998; Hoofer and others, 2006; Piaggio and others, 2002). Similarly, methods for estimating abundances of bats have lagged far behind those applied to other groups of small mammals, and estimating population sizes beyond counts of bats at specific roosts is not yet possible with any validated accuracy or useful level of precision. Even the means of capturing bats have numerous biases that make judgments of "relative abundance" difficult. Using mist nets set over water, for example, can be biased by the morphology and flight characteristics of each species. Some species are highly maneuverable with low aspect ratios and low wing loading and not only can avoid mist nets, but are probably more likely to use small isolated pools of water for drinking. Less maneuverable species are more easily captured, and they are more likely to favor larger bodies of water with more open approaches. Capturing bats as they drink or feed over water surfaces probably also varies in success with the amount of water present in a landscape and with seasonal changes in these amounts. Various limitations to assessing abundances of bats are described in detail in the report edited by O'Shea and Bogan (2003).

Patterns of reproduction are of interest in bat surveys as a measure of response to environmental conditions. The annual cycle of reproduction in western bats can vary among years, locations (especially with elevation), and species, but in general has the following sequence. The age of sexual maturity is usually about one year old in both sexes, but some individuals can mate in their first year of life. The testes become active in summer, but the sperm are then stored in the caudal epididymides and mating takes place in either fall or winter just before or during hibernation. Females typically follow a strategy wherein development of young is delayed until the warmer, more productive weather of late spring and early summer. This strategy usually involves storing sperm (which can remain viable for several months) in the uterus in winter and delaying ovulation until spring. Some species utilize other mechanisms towards the same ends, such as earlier fertilization but with arrested embryonic development and delayed implantation. In Colorado usually only a single embryo develops in most species of bats at each pregnancy. There is little plasticity in reproductive output of temperate zone bats in response to variability in environmental conditions. Numbers of litters per year are limited to one because of winter cold and lack of insect food, and usually only a singleton is born because of weight restrictions for flight and the need for the young to be nursed, develop fully, and store fat reserves before winter. The exception is for adult females to forego reproduction entirely, and this variability in reproducing is reflected in the "reproductive rate" in a given summer, typically expressed as the percentage of a sample of females that shows signs of reproduction such as detectable pregnancy or lactation (Barclay and others, 2004). Reproductive rates can be very high under optimal conditions, but in some areas and under poorer conditions they can be quite low. For additional information on reproduction and life history traits in bats see Crichton and Krutzsch (2000) and Barclay and Harder (2003).

Within many species of Colorado bats, females gather in "maternity colonies" of varying size in summer. These roosts are in structures where ambient temperatures are warm, such as crevices in trees and rock exposed to the sun, and the females cluster and use each other's body heat to further maintain warm temperatures and enhance rapid development of young. Each female gives birth to a single young in early summer (late June, for example) and the altricial juveniles grow rapidly in these warm maternity sites. Births are fairly synchronous but can be spread out over a few weeks. When young are about 4 weeks old they are nearly adult sized, weaned, and make regular nightly flights. It is becoming widely recognized that adult males and females can occupy separate regions in summer, particularly in areas of the Western United States that show significant zonation in elevation (see for example Cryan and others, 2000; Neubaum and others, 2006). Females will favor warmer, lower elevation sites for reproduction in summer whereas males occur more regularly at cooler, higher elevations. This differential distribution can be reflected in skewed adult sex ratios, with more males taken at higher elevations in summer. On an annual, distribution-wide basis sex ratios of bats are usually about 1:1. Kunz and Lumsden (2003) summarize much additional information on the maternity habits and roosting ecology of bats.

Given this background, we report our findings on the bat fauna of Mesa Verde in relation to the differential occurrence of male and female bats, evidence for reproduction in various species of bats, and how reproduction and occurrence of different species and sexes may vary by elevation within the park. Mesa Verde encompasses a diversity of elevations. Most of the sites where it was feasible for us to capture bats were located near the mesa tops. However, because Mesa Verde slopes downward toward the south, there were differences in elevation at our various capture locations that are of potential biological significance to bats. Additionally, we compiled information that pertains to bats at Mesa Verde from other sources. These resources include previous publications, unpublished data, and records from specimens in museum databases. This information provides a more comprehensive overview of the bats at Mesa Verde National Park. We also make comparisons between our survey results and past findings for evidence of major patterns of change in bat fauna composition and reproduction. This information is of particular interest because of the large landscape-level changes that have occurred at Mesa Verde over the past decade as a result of prolonged drought and major fires.

Methods

This phase of the study involved two aspects. The first was to survey the bat fauna by capturing, identifying, noting the reproductive condition of, and releasing bats. This method is most efficiently done by placing mist nets in areas where bats are likely to fly near the ground to drink or forage (Kunz and others, 1996). Because much of the landscape at Mesa Verde has suffered widespread fires over the recent past, siltation and runoff have buried most of the springs and water pools in canyon bottoms where bats were captured during the most comprehensive of the past surveys, carried out in 1989–1994 (Chung-MacCoubrey and Bogan, 2003). This change in waterbodies forced us to concentrate our mist-netting along the margins of four sewage treatment lagoons at various locations within the park (table III.1; fig. III.1). At sewage lagoons we generally set all nets possible given our equipment, averaging 91 m of coverage each night using nets that were set on 3-m-high poles. On nine nights at three of the sewage lagoons we also set multiple 20-m-long stacked nets at 6-m heights using a pulley system. Nets were tended from dusk until midnight or later, depending on weather. We also netted for bats at the drainage tunnel under the Cliff Palace on one night. Bats were known by park staff to concentrate nightly activity for unknown purposes at this tunnel. We also set nets on two nights near the stairwell at the Far View Visitor Center, a site where bats were known by park staff to hang up and night roost at night between foraging bouts. For each bat captured we determined sex and reproductive condition following criteria in Racey (1988). Pregnancy was assessed by palpation (most reliable at advanced stages), lactation by prominence of nipples and teats (verified by expression of a milk droplet when possible), and post-lactation. Bats were categorized as adult or volant juvenile (young-of-the-year) based on ossification of the phalangeal epiphyses (Anthony, 1988) as viewed against a light source. The elevations of the sites where we captured bats in mist nets varied from 1,939 m to 2,476 m (table III.1). For some analyses we grouped records into lower elevation (≤ 2,165 m) and higher elevation sites (≥ 2,311 m) to determine if different patterns in use by various species, sexes, and reproductive classes of bats were evident within Mesa Verde. We provide tabulations and qualitative summaries of the results from the first summer of the survey. These data have not yet been adjusted for measures of effort such as total net-nights at a site or in relation to surface area of water at each site. The capture data are also provided as an appendix to this report (appendix III.1). We were greatly assisted in the bat survey and capturing work by Colorado State University graduate student E.A. Snider and her crew (K. Briones, J. Much, and J. Lamb) and by our colleagues L. Ellison, D. Neubaum, and P. Cryan.

In this report we also provide a summary of our efforts to compile the past records of bats at Mesa Verde through a literature survey and search of museum databases. We queried some museums directly and also queried the Mammal Networked Information System (MaNIS) database (http://manisnet.org/). The latter provides online access to mammal collection data for a consortium of 30 natural history museums in the United States. The major source of data for bats of Mesa Verde was the U.S. Geological Survey (USGS) collection at the Museum of Southwestern Biology (MSB) at the University of New Mexico. Most of the specimens in this collection stem from an intensive survey carried out by U.S. Fish and Wildlife Service (USFWS) mammal specialists in 1989–1994 (reassigned to the U.S. Geological Survey in 1996). The USFWS survey also forms the basis for the excellent account of the bats of Mesa Verde by Chung-MacCoubrey and Bogan (2003). A summary of the MSB data is also provided as an appendix to this report. There are minor discrepancies between Chung-MacCoubrey and Bogan (2003) and the tallies from the MSB database regarding the total numbers of bats counted for a few species. . We suspect these discrepancies involve re-examination and reassignments of identifications by Chung-MacCoubrey and Bogan (2003) that have not been revised in the MSB collections database. Nearly all of these discrepancies pertain to the California myotis (*Myotis californicus*) and the western small-footed myotis (*Myotis ciliolabrum*). These two species are difficult to distinguish and have been the subject of various taxonomic revisions (for background see for example Rodriguez and Ammerman, 2004). We will resolve these discrepancies prior to making our final report. Our data tabulations for comparisons with the 2006 survey are based on the MSB database alone and are limited to the specimens captured on the USFWS surveys in 1989–1994.

Unlike the USFWS and other surveys, we collected only a very limited number of voucher specimens in 2006. These specimens consisted of: (1) two California myotis and two western small-footed myotis that we felt required documentation as vouchers because of taxonomic issues as noted above and in Chung-MacCoubrey (2005); (2) one Yuma myotis (*Myotis yumanensis*) because we obtained new park records for this species in 2006; and (3) one canyon bat (*Parastrellus hesperus*, also referred to as the western pipistrelle) because in 2006 we obtained the first records at Mesa Verde in over 40 years. We also prepared voucher specimens of one canyon bat and one long-eared myotis (*Myotis evotis*) that died during handling. These specimens will be accessioned into the collection at the MSB, with further details to be provided in the final report in 2008.

Results

The Bat Fauna in 2006

We captured 913 bats in mist nets set over water at Mesa Verde in 2006 (table III.2; appendix III.1), not including 25 additional bats taken by the Colorado State University team at two lower elevation netting sites on the Hollub and Colyer properties near the northeastern boundary of the park. These latter records are similar to those obtained at Mesa Verde in species composition but are not included in totals for our survey at the park. The 913 bats were captured at 8 sites on 58 nights (table III.3). Nearly all (53 nights) of the netting effort in 2006 was focused adjacent to three sewage lagoons (Morefield, Far View, and Cedar Tree Tower) where bats visited nightly to drink and forage. We also netted bats at the Wetherill Mesa sewage lagoon and over the Mancos River on one night at each location, and across the entrance to the tunnel under Cliff Palace on one night. We attempted to capture night-roosting bats at the Far View Visitor Center stairwell on two nights.

Fifteen species of bats were documented by captures at Mesa Verde in 2006 (table III.2, figs. III.2 and III.3). The fauna was characterized by one abundant species (long-legged myotis [*Myotis volans*], 36 percent of all bats captured), five moderately common species accounting for 6–16 percent of total captures each (long-eared myotis, silver-haired bats [*Lasionycteris noctivagans*], big brown bat [*Eptesicus fuscus*], western small-footed myotis, occult myotis [*Myotis occultus*]), and nine species that each represented less than 3 percent of total captures (table III.2, figs. III.2 and III.3). Review of the regional faunal literature shows that the six most abundant species of bats at Mesa Verde are bats that are commonly reported to inhabit mid-elevation forested sites in the Rocky Mountains and Southwestern States (appendix III.2). The nine less common species can be categorized as bats that are chiefly inhabitants of zones warmer, more arid, and of lower elevation than those sampled (five species: pallid bats

[*Antrozous pallidus*], California myotis [*Myotis californicus*], Yuma myotis, canyon bat, and Brazilian free-tailed bat [*Tadarida brasiliensis*]; appendix III.2); or are typical of the zones in which we sampled but are bats that often fly above ground at heights that are usually far above mist nets (spotted bat, *Euderma macultum*); or are very adept at maneuvering and avoiding nets (Townsend's big-eared bat, *Corynorhinus townsendii*), habits that make them less likely to be captured. The remaining two species consist of one that is highly migratory (hoary bat, *Lasiurus cinereus*) and apparently not commonly captured outside of migration in Colorado (appendix III.2), and one that is typical of the areas we sampled but apparently uncommon (fringed myotis, *Myotis thysanodes*). In addition to bats captured in hand, we also heard and recorded calls of the big free-tailed bat (*Nyctinomops macrotis*; see Ellison, Section V, this report).

Most (13 of 15) species of bats at Mesa Verde occurred at both lower and higher elevation netting sites (table III.4). Exceptions were the sole pallid bat capture, which took place at a lower elevation site, and all occult myotis captures, which took place at the higher sites. Considering that greater effort (numbers of nights netting, table III.3) was made at higher elevation sites, four species appeared to be more common at the lower elevation sites: big brown bats, California myotis, western small-footed myotis, and canyon bat (table III.4). Two of these species indeed are generally considered to be more typical of lower elevations (California myotis and canyon bat), whereas big brown bats and western small-footed myotis are widespread but typical of middle elevations (appendix III.2).

Capture success was very variable at each site from night to night, with comparable nights at the same site ranging from 0–1 capture to over 80 captures (appendix III.1, table III.5). These data suggest that bats may shift locations of activity for more complex reasons than availability of water resources alone (such as localized transient concentrations of insects, or meteorological factors such as wind shifts, rainfall, or temperature). Capture success also seemed to vary among the summer months. In general, species richness and numbers of bats captured per night peaked in June at all sites (table III.5), then dropped in July and were low in August. This pattern may be due to a shifting of females to lower elevations for reproduction (but see next section below), or may simply be due to a greater availability of water for bats in July and August with the advent of summer monsoons and pooling of water coupled with lower physiological demands for water than in June, the driest (fig. III.4) and usually hottest of the summer months. Evening winds and rain associated with the southwestern monsoonal pattern also curtailed bat activity, and on three nights in July and August caused us to terminate netting attempts earlier than midnight for safety (lightning) and comfort.

Sex Ratios, Seasonal and Elevational Distributions, and Reproduction of Bats in 2006

Five of the fifteen species of bats we captured at Mesa Verde had sex ratios very highly skewed towards males: silver-haired bats, hoary bats, big brown bats, Brazilian free-tailed bats, and canyon bats (table III.2); only one of these species (canyon bat) showed evidence for reproduction at Mesa Verde (tables III.2 and III.6). This skewed distribution is not unexpected for these species. Silver-haired bats were the third most abundant species of bat. However, only 5 of the 135 adult silver-haired bats captured were females, and all of them were caught on May 23 or earlier, indicating that they were females in spring migration. These data are consistent with the general continental patterns in the seasonal distribution of silver-haired bats, with males found primarily in mountainous areas of the Rocky Mountains and females found at lower elevations to the north and eastward (Cryan, 2003). No volant juvenile silver-haired bats were captured at Mesa Verde in summer, also conforming to this pattern of absence of females in summer. No female hoary bats were captured. This species is another continental migrant that follows a pattern of differential distribution of the sexes similar to silver-haired bats (Cryan, 2003). Adult male hoary bats were captured in low numbers (total of 12) in all months of the summer at Mesa Verde. Big brown bats were common, and all of the 55 we captured through July 14 were males. A few (6) adult female big brown bats were taken later in July and August, but the preponderance of big brown bats caught later in summer continued to be males (24 of 30). Brazilian free-tailed bats were taken in low numbers (total of 6) but all were male, consistent with a general pattern of almost exclusively males occurring in much of Colorado (Freeman and Wunder, 1988). Only one of the 18 canyon bats we captured was an adult female, and this bat was post-lactating when captured on August 7. We suspect female canyon bats may be more abundant and reproduce at lower elevations within canyon bottoms, and were unlikely to be captured at the lagoons on mesa tops and upper reaches of canyons. Only one individual pallid bat was captured, a male.

Sex ratios of adults of a few other species at Mesa Verde also seemed to favor males (table III.2) but not as dramatically as in the above four species. These species were the western small-footed myotis, long-eared myotis, fringed myotis, and Yuma myotis. Sample sizes were small however, particularly in the fringed myotis (n=19) and Yuma myotis (n=7). Females were numerically dominant over males in the most abundant species, long-legged myotis, and clearly used the mesa tops during reproduction. We captured 310 adult long-legged myotis, and 240 of these adults were females (77 percent female, table III.2).

Our capture records for the occult myotis are limited but suggest that many of these bats leave Mesa Verde for the period from late June to early August. We captured 25 adult females through June 26 (appendix III.1; 7 of 7 were pregnant on June 23–26), then only one additional adult female (lactating, on July 15) was captured until August 8, when females apparently returned to these sites (with nine captures through August 27). Only one juvenile occult myotis was captured at Mesa Verde, but not until August 8. Adult male occult myotis also followed this pattern of absence between late June and August (14 captured through June 26, 11 captured on August 8 or thereafter, and none taken between these dates). Radiotagging verified that adult female occult myotis moved to roosts at lower elevations (see Cryan, Section IV, this report). The presence of occult myotis in late spring and late summer suggests that these bats hibernate at the cooler elevations of Mesa Verde in winter. Occult myotis were only captured at the higher elevation Morefield and Far View sewage lagoons.

We obtained evidence for reproduction in females of 10 species of bats at Mesa Verde (table III.2). The general period when birth and lactation take place seems to be from late June to about the fourth week of July (table III.6). Adult female long-legged myotis examined between June 20 and July 26 showed a reproductive rate of 33 percent (50 of 150 examined, table III.7). This sample may be biased negatively if some pregnancies were not yet detectable by June 20. Collapsing the dates to the period June 30 to July 20 (when detectability of pregnancy was likely greater) resulted in the slightly higher proportion of 39 percent (39 of 100) of adult female long-legged myotis in reproductive condition. We captured only three other species of bats at Mesa Verde during the June 20 to July 26 time period with sample sizes of more than 10 adult females. Reproductive rates were also seemingly low in the western small-footed myotis (6 of 17; 35 percent), and the long-eared myotis (12 of 27; 44 percent). The California myotis had a higher reproductive rate but sample size was low (7 of 11; 64 percent).

Our records of adult females in reproductive condition partitioned between our two categories of higher elevation and lower elevation sites are weakly supportive of the hypothesis that lower elevations may be more favorable to reproduction in some species, particularly considering the bias towards more effort at netting at higher elevation sites. The hypothesis appears tenable for the California myotis and western small-footed myotis (table III.8), but sample sizes are small for these species. The occult myotis were confirmed by telemetry to favor lower elevations in the Mancos Valley during the maternity period (see above and Cryan, Section IV, this report). There was no apparent tendency for disproportionate reproduction at lower elevation sites in long-legged myotis and long-eared myotis (table III.8). It is worthy of note, however, that at the higher-elevation Morefield sewage lagoon site we captured a high number of *Myotis evotis* (61) with a male-biased sex ratio (about a third [21] of them were adult females). None of the adult female *M. evotis* captured at this site was in notable reproductive condition (one was post-lactating on July 15). Ten of the 21 were captured in May when reproductive status is not easy to discern, but 8 of the remaining

10 were caught between June 7 and 24 and were categorized as nonreproductive; two taken on August 9 and 20 were also classed as nonreproductive. This species may also have a tendency to move to lower elevations to give birth and rear young (see Cryan, Section IV, this report; also, E. A. Snider, unpub. data regarding telemetry findings, 2006; perhaps nonreproductive females remain at higher elevations similar to those occupied by males. Evidence for shifts in females to lower elevations from June to July may be slightly supported by sex ratio data for three species of myotis bats other than the long-legged and occult myotis (table III.9), acknowledging the caveat that these ratios are not based on large sample sizes. In the long-eared myotis sex ratios shifted to favor females from June to July at lower elevations, whereas males dominated at higher elevations in both months. Adult female California myotis and western small-footed myotis were captured at lower elevation sites in both months, but no females of either species were captured in July at higher sites. The long-legged myotis showed sex ratios consistently favoring females regardless of location or month of sampling, suggesting that Mesa Verde provides adequate conditions for reproduction in this species at most sites in the park. Male long-legged myotis may occupy areas off the park (perhaps at higher elevations in nearby mountain ranges), assuming a 1:1 sex ratio in the overall population.

The very low abundance of juveniles of all species at all netting sites (table III.2) also suggests that young bats were not foraging at the higher elevations typical of most of our netting sites at Mesa Verde, and were perhaps remaining in the vicinity of maternity colonies at lower elevations in nearby canyons or lowlands. However, netting success was low in August at Mesa Verde due to unknown biases. Similar decreases in bat echolocation activity also occurred at Mesa Verde in July and August (Ellison, Section V, this report), suggesting that perhaps bats were concentrating their foraging activity at lower elevations at this time, were more dispersed across the landscape, or were spending more time inactive in torpor.

Specimen Records from Previous Surveys

We found records of 189 specimens of bats fromt Mesa Verde National Park at the MSB, and records for an additional 101 specimens (as well as other records such asaudible observations or bats captured and released) at Mesa Verde or nearby localities in Montezuma, Dolores, or LaPlata Counties, Colo. (appendices III.3 and III.4). Published accounts of the bat fauna appear in three scientific publications (Anderson, 1961; Douglas, 1967; and Chung-MacCoubrey and Bogan, 2003) that take account of most of the specimens. This past work documented the presence of 13 species of bats at Mesa Verde and nearby locales. Eight species (California myotis, long-eared myotis, western small-footed myotis, fringed myotis, long-legged myotis, big brown bat, Townsend's big-eared bat, and Brazilian free-tailed bat) were documented based on collections or examination of specimens by Anderson (1961). The canyon bat (western pipistrelle) was documented by Douglas (1967), who also found a dead hoary bat 1.0 km north of the park boundary in 1963. The presence of the hoary bat in Mesa Verde was verified by the collection of a single individual during the 1989–1994 USFWS surveys (Chung-MacCoubrey, 2003), which also documented the silver-haired bat and the pallid bat. None of the records that we obtained from museum databases, other publications, or unpublished sources added to the list of species documented in publications by Anderson (1961), Douglas (1967), or Chung-MacCoubrey and Bogan (2003).

Comparison of Previous Survey Findings with the 2006 Surveys

The largest series of specimens of bats from Mesa Verde National Park is housed at the Museum of Southwestern Biology at the University of New Mexico (appendix III.3). Most of these specimens (177) were obtained during biological surveys of Mesa Verde carried out by USFWS personnel (from a unit now part of the U.S. Geological Survey). Those specimens were obtained in warm season months in 1989–1994. This collection differs from our survey in several respects that must be considered in comparisons of results. The FWS records are biased towards the month of August (107 records), but also include specimens taken in June (37 records) and July (33 records), allowing some general comparisons with our results from 2006. We sampled bats over water on 58 nights, primarily at three locations centered on sewage lagoons (53 nights), whereas the specimens taken in the USFWS survey were obtained on 22 nights at 11 locations visited for short periods over four calendar years. Most of the USFWS collecting locations were in canyons over small pools of water. Since that study these pools have filled with silt from post-fire runoff or otherwise have gone dry with the prolonged drought, and we were thus unable to repeat sampling at the same sites. However, 85 of the specimens from the FWS surveys were captured at locations in Morefield Canyon, including 7 at the Morefield sewage lagoons. We selected this subset of the data as the most reliable basis for comparison at a nearby locality (below).

Anderson (1961) collected mammals at Mesa Verde in 1956 and obtained 18 bat specimens of 7 species by gunshot (primarily at Rock Springs) and mist net set across an opening made by a dirt road entering a piñon-juniper stand on Wetherill Mesa. He sampled bats only in mid to late August and thus had no information on reproduction. He captured or shot two California myotis, three long-eared myotis, five western small-footed myotis (referred to as *Myotis subulatus* at the time), one fringed myotis, one long-legged myotis, one big brown bat, and five Townsend's big-eared bat (four from a roosting group in "a fracture in the rocks at the bottom of the canyon wall, above the talus slope" at Square Tower House; Anderson, 1961, p. 39). Anderson (1961) also summarized the history of past mammal surveys at Mesa Verde and noted the existence of seven additional specimens in various collections, including two male Brazilian free-tailed bats in the park collection taken at Cliff Palace by Borell in 1936.

Douglas (1967) collected the first three specimens of canyon bats (housed at the University of Kansas Museum of Natural History) by gunshot near park headquarters in 1964 and 1965, and found a dead hoary bat outside but very near the park boundary (1.0 km north) in 1963 (Douglas 1967). The totals reported by Anderson (1961) and Douglas (1967) documented ten species of bats known from Mesa Verde prior to the 1989–94 surveys. The USFWS surveys found 11 species of bats in 1989–1994 (table III.10), adding silver-haired bats and pallid bats to those documented by earlier work but not capturing canyon bats or free-tailed bats. All 11 species found in 1989–1994 were also among the 15 species we found in 2006. The four additional species we captured were spotted bats, Yuma myotis, canyon bats, and Brazilian free-tailed bats. These species were not among other specimens from Mesa Verde at the Museum of Southwestern Biology. Spotted bats and Yuma myotis were completely new records for Mesa Verde. Neither species had been captured previously in Montezuma County. The nearest records in Colorado documented in the literature were a single specimen of the Yuma myotis from La Plata County and a specimen and other record of the spotted bat from Moffat County (Armstrong and others, 1994).

The relative abundance among species in the USFWS survey records was somewhat different from our sample (figs. III.2 and III.5). The long-eared and long-legged myotis were the two most frequently captured species in both surveys, but they held opposite ranks (figs. III.3 and III.6). Silver-haired bats were a much higher proportion of the total captures in 2006 than in the earlier USFWS surveys. Part of this seeming discrepancy may be attributable to our sampling in May, whereas during the earlier surveys the first date of sampling in any year was June 6. We captured 40 of the 130 silver-haired bats in May, presumably during spring migration. However, this occurrence would not alone account for both the proportional and numerical differences between the two surveys in the numbers of silver-haired bats. An additional difference in the biases of the two surveys may be in the configurations of the netting areas. The USFWS surveys generally sampled over smaller pools, which may not be frequented often by the less maneuverable, faster flying species. This discrepancy would account for the higher numbers of captures and relative abundances of silver-haired bats, hoary bats, Brazilian free-tailed bats, and perhaps big-brown bats that we captured in 2006 when our sampling was concentrated around the large, open sewage lagoons. Netting bats at smaller pools may instead produce higher numbers and relative abundance of very maneuverable species that can easily drink at these sites, such as the long-eared myotis and Townsend's big-eared bat.

The relative proportions of total captures by species are grossly comparable between the 2006 captures at Morefield sewage lagoon and the USFWS survey results at combined Morefield Canyon sites (figs. III.7 and III.8). The relative rankings of the three most abundant species (long-eared myotis > long-legged myotis > silver-haired bats) were similar between the two studies, with the most pronounced differences being the larger proportion of silver-haired bats and occult myotis in 2006. Only one occult myotis was captured at Mesa Verde in the USFWS survey, taken from the Morefield Canyon sewage lagoon. This site was also one of just two sites where this species was captured in 2006, and accounted for 41 of 60 captures of the occult myotis in 2006.

Overall, the evidence for reproduction, presence of juveniles, and sex ratios were comparable between the two studies (table III.10). Three species of bats captured in the USFWS surveys were represented by 10 or more adult females. We calculated reproductive rates for these species but were more liberal in the dates we bracketed as periods of high detectability of pregnancy, lactation, or post-lactation. We reasoned that unlike the 2006 samples, which we captured and released at night, these bats were dissected under good light and reproductive traits less conspicuous externally could be diagnosed based on internal anatomical characteristics (presence of embryos, milk, or hypertrophied mammary tissue). For this sample we characterized reproductive rates over the period June 6 through August 6 (all years combined). Reproductive rates were as follows: 38 percent for Townsend's big-eared bat (5 of 13); 57 percent for the long-legged myotis (16 of 28); and 11 percent for the long-eared myotis (4 of 35; but 4 of 19 [21percent] from the more restrictive period June 6 to July 27). The USFWS surveys captured 128 bats between July 27 and August 15 (all years combined), when juveniles were likely to be detected. Eight were recognized as juveniles in museum records based on notations regarding fusion of epiphyses. These specimens were limited to one long-eared myotis (2 percent of 53 specimens), and seven long-legged myotis (20 percent of 35 specimens). During this same period in the 2006 surveys (appendix III.1), we did not capture any juvenile long-eared myotis (out of only six long-eared myotis taken during this period); one juvenile long-legged myotis was captured out of five taken (20 percent).

Comparisons of elevational differences by species, sex, and reproductive condition were limited because of differences in collection sites, species composition, times of the year, and sample sizes between the two studies. Overall, these traits might be grossly compared best between the two surveys using capture records from the Morefield sites. The long-eared myotis was the most abundant species taken at Morefield in the 1989–1994 USFWS surveys, with an even adult sex ratio of 1:1 (20 males and 21 females). In 2006 the ratio at the Morefield sewage lagoon was much more biased towards males, at 2:1 (40 males and 21 females). The only other species taken at the Morefield sites in any abundance (more than 5 specimens) in the earlier surveys was the long-legged myotis. The adult sex ratio for this species was skewed towards females at 0.3:1 (5 males, 18 females) at the Morefield sites in the USFWS surveys, and again at 0.3:1 in the 2006 surveys (13 males, 38 females).

Miscellaneous Observations and Sampling of Bats

We captured bats in a mist net we set at the opening of the drainage tunnel under the Cliff Palace on the night of July 12, 2006. We captured 72 bats between 8:51 p.m. and 11:35 p.m., with most (58) captured within the first hour. All of these bats were entering the tunnel after emerging from roosts elsewhere. Five species were captured: long-legged myotis (n=63), long-eared myotis (n=5), California myotis (n=2), fringed myotis (n=1), and Townsend's big-eared bat (n=1). Two lactating long-legged myotis and one lactating fringed myotis were radiotracked to diurnal roosts (see Cryan, Section IV, this report). The two long-legged myotis roosted nearby in Cliff Canyon (UTM 724268 4116076). A signal from the transmitter on the fringed myotis came from the general area of cliffs in Soda Canyon. We returned on July 16 to observe and videotape bats inside the tunnel using low-light cameras and infrared supplemental lights. Most bats used the first third of the tunnel, but a few flew the entire length. Bats were documented drinking from very small pools of water near the tunnel entrance. The white deposits suggest the water may also be a good source of dissolved calcium for reproductive females. Heavy dripping from ceilings and walls towards the rear of the tunnel also suggest some bats may be drinking in air. The sex ratios and reproductive status of the bats captured, however, do not show disproportionate use by females or by reproductive females. The Townsend's big-eared bat was an adult male, the California myotis were an adult male and a nonreproductive female, and the fringed myotis was a lactating female. The five long-eared myotis consisted of three adult males and two nonreproductive females. The long-legged myotis sample were all adults (59 of 59 with age determined), with 14 males and 45 females. This sex ratio (0.3 M: 1 F) is identical to the parkwide sex ratio for this species. There were 15 lactating females out of 44 total female long-legged myotis for which reproductive status was noted. The remaining bats were nonreproductive, for a reproductive rate of 34 percent, equivalent to the parkwide reproductive rate of 33 percent for this species.

We observed and sampled ectoparasites from bats as time permitted during handling of bats for the parkwide survey throughout the summer. We also sampled fresh guano pellets from a few bats August 14–20, and gave these samples to a virology laboratory at the University of Colorado Health Sciences Center interested in surveying bats for coronaviruses. There is little information known on ectoparasites from bats in the Western United States and more specifically bats occurring at Mesa Verde National Park. Bats were examined for ectoparasites prior to release. Most large ectoparasites such as bat/bed bugs, wingless flies, ticks, and fleas, were easily seen on the bat and were plucked using forceps. Ectoparasites were then placed in vials of 95 percent ethanol for future identification at the USGS Arid Lands Field Station. When possible, bats were examined under a dissecting scope at the netting site for smaller ectoparasites that include wing and fur mites. Often these small ectoparasites were found clinging to individual hairs or were found crawling on the wing membranes. These parasites were also plucked from the fur and skin then placed into vials of ethanol for further identification. Approximately 82 ectoparasites were retrieved from 41 bats. Totals for larger ectoparasites include: 10 fleas, 21 bat flies, 4 bat/bed bugs, 5 ticks, and 5 wing mites. Count of the smaller fur and skin ectoparasites totaled to approximately 37 individuals, however more may be identified once specimens are mounted onto microscope slides. Ectoparasites collected in 2006 were removed from 13 bat hosts including *Myotis californicus*, *M. ciliolabrum*, *M. evotis*, *M. occultus*, *M. thysanodes*, *M. volans*, *M. yumanensis*, *Corynorhinus townsendii*, *Eptesicus fuscus*, *Parastrellus hesperus*, *Lasionycteris noctivagans*, *Antrozous pallidus*, and *Tadarida brasiliensis*.

Fresh fecal pellets were collected from 21 bats captured at sewage lagoons during the surveys on August 14–20 and placed in vials of RNALater. These samples were taken from 8 occult myotis, 6 long-legged myotis, 3 big brown bats, 2 silver-haired bats, and 1 Brazilian free-tailed bat. They were provided to the laboratory of Dr. Kathyrn Holmes at CU-Medical Center, an internationally recognized researcher on coronaviruses. Based on reverse transcriptase-polymerase chain reaction (RT-PCR) analysis of the genome, evidence for coronavirus was found in five occult myotis and one big brown bat. There were at least two distinct viruses in the sample, both of which are new to science and one of which is most similar to a coronavirus from a different species of *Myotis* from China. This find is the first evidence of coronoaviruses in New World bats. Coronaviruses are a large group of viruses with several species known worldwide in domestic animals and humans, where they can be found in the digestive tract and other organs. They are likely to be abundant in bats, of low pathogenicity, and unlikely to infect other species. However, little is known about their biology in bats and simply nothing is known about coronavirus infections in North American bats in particular, beyond molecular characterization of the genome. Coronaviruses are expected to be widespread and common throughout bats of the world, but they have not yet been widely surveyed.

Discussion

Mesa Verde National Park has a diverse bat fauna. We documented 15 species by in-hand captures in 2006, and a 16th species based on recordings of unique vocalizations (see Ellison, Section V, this report). These data represent 16 of the 18 species of bats known to occur in Colorado (based on Armstrong and others, 1994; and Fitzgerald and others, 1994, who did not differentiate the occult myotis from the little brown myotis, *Myotis lucifugus*). The two remaining species of the 18 reported in Colorado are the eastern red bat (*Lasiurus borealis*) and the eastern pipistrelle (*Perimyotis subflavus*), known only from the eastern plains and not anticipated in the Rocky Mountains on either side of the Continental Divide. Thus Mesa Verde is home to all species of bats known in western Colorado. We captured four additional species not documented in the 1989–1994 surveys, and two species never before documented from Mesa Verde by bats captured in hand (Yuma myotis and spotted bat). K. Navo (unpub. report, Colorado Division of Wildlife, 1994) documented the likely presence of the big free-tailed bat at Mesa Verde by audible calls, a finding repeated in 2006 (Ellison, Section V, this report). In July 2004 Alice Chung-MacCoubrey (appendix III.4) captured and released a big free-tailed bat on the Mancos River and tracked it to a roost near Mesa Verde.

The 16 species of bats at Mesa Verde are a species-rich fauna in an area characterized primarily by piñon-juniper woodlands. The most comparable study of bats in this habitat type in reasonably close geographic proximity to Mesa Verde is the work of Chung-MacCoubrey (2005) in the piñon-juniper woodlands of the Gallinas Mountains of New Mexico. That study netted bats over water at eight sites on 55 nights during three summers. Ten species were documented (California myotis and western small-footed myotis were not distinguished separately). All of these species were also found at Mesa Verde. Why does the Mesa Verde bat fauna have greater species richness than the New Mexico piñon-juniper site? The Gallinas site is comparable in elevation (2,133 to 2,573 m) to our main netting locations at Mesa Verde, the dominant vegetation type is the same, and the bat fauna of New Mexico incorporates all the species of bats that are found in Colorado as well as others. We suspect that the difference in species richness between the two bat faunas is primarily the availability of rock crevices in cliffs and canyon walls as potential roosting sites at Mesa Verde. It has long been recognized that roost availability increases with greater topographic complexity and the presence of structural features such as cliffs and rock outcrops, and that this complexity is correlated with higher bat diversity across North America (Humphrey, 1975). Indeed, three of the four species that were not documented in the Gallinas Mountains but were found at Mesa Verde (canyon bat, Townsend's big-eared bat, and spotted bat) are well-known throughout the southwest to roost primarily in rock crevices, rock shelters, and caves rather than in piñons, junipers, or other associated trees. Our radiotracking studies also bear out that rock roosts were favored by most of the bats we radiotagged at Mesa Verde (Cryan, Section IV, this report), and echolocation activity was high at sites near canyon rims (Ellison, Section V, this report). Clearly the high mesas bisected by numerous canyons and cliff faces provide very favorable roosting habitat for bats. It is our opinion that this feature overrides any extensive reliance on piñon or juniper trees and snags as roosts by bats.

Our findings regarding sex ratios and reproduction in the Mesa Verde bat community, however, point to the existence of limiting factors other than roost availability. The upper reaches of canyons and mesa tops where most netting took place may be at elevations that are too high and cool to be favorable for reproduction by some species of bats. (Lower elevations provide warmer roosts for females to rear young and, likely, higher insect densities to support the nutritional demands of lactation and the maintenance of higher body temperatures. Higher elevations used by males and nonreproductive females can compensate for lower insect availability by allowing for deeper daily torpor). Some species of bats were captured at sex ratios strongly skewed in favor of males at most locations in the park. These species included silver-haired bats, hoary bats, Brazilian free-tailed bats, and big brown bats. The skewed sex ratios of silver-haired bats and hoary bats are consistent with the general continental patterns in their seasonal distribution, with males found primarily in mountainous areas of the Rocky Mountains and females found at lower elevations to the north and eastward (Cryan, 2003). Neither species reproduced at Mesa Verde, nor would such be expected based on this continental pattern. Reproductive female Brazilian free-tailed bats are seldom found anywhere in Colorado and favor lower, warmer, and more southern locations for formation of maternity colonies (Armstrong and others, 1994; Fitzgerald and others, 1994; Freeman and Wunder, 1988). Big brown bats are common in Colorado, but there is increasing evidence that female big brown bats use the lower, warmer elevations to form maternity colonies (often in buildings) while males uses higher cooler elevations in summer, with both sexes hibernating in rock crevices at cooler elevations in winter (Neubaum and others, 2006, in press). Our netting results coupled with radiotracking (Cryan, Section IV, this report) suggest a similar pattern for female occult myotis at Mesa Verde. Netting results also suggest that in several other species of bats at Mesa Verde, near-term pregnant and lactating females may favor lower elevations. We found little or no evidence for reproductive females at higher elevation sites for the canyon bat, the California myotis, western small-footed myotis, and occult myotis. Although reproductive female long-eared myotis were found at higher elevation sites at Mesa Verde, these sites were generally skewed towards a greater abundance of adult males. Others have also noted a preponderance of males at higher elevations at other study areas in various species, including the California myotis, western small-footed myotis, and Yuma myotis (see review in Cryan and others, 2000). Evidence for consistent use of netting sites at all elevations at Mesa Verde by reproductive females was strong only for the long-legged myotis and to a lesser extent long-eared myotis. The long-legged myotis was also the only species with adequate sample sizes that had sex ratios highly skewed in favor of females at all sites. Long-legged myotis can be the most abundant bat at higher elevation forests (up to 2,900 m) in Colorado, where they have been documented with sex ratios skewed towards females (all nonreproductive; Storz and Williams, 1996). Long-eared myotis are also known to be a species that frequent mid to upper elevation coniferous forest zones in the Rocky Mountain states (Armstrong and others, 1994; Barbour and Davis, 1969; Fitzgerald and others, 1994; Manning and Jones, 1989).

In addition to sex ratios skewed against females in several species of bats at Mesa Verde, our information concerning reproduction suggest that many of the adult female bats at Mesa Verde were nonreproductive in summer 2006, resulting in low reproductive rates. The largest sample size was for the long-legged myotis, in which 33 percent of adult females were reproductive. This rate is a relatively low reproductive rate for this species; a variety of unpublished sources summarized by Barclay and others (2004) provide a mean reproductive rate of 51percent for long-legged myotis (though these findings are primarily in Canada). Reproductive rates for California myotis, western small-footed myotis, and long-eared myotis (table III.7) were all also lower than the mean values for these species summarized by Barclay and others (2004), although the range of variation in these studies was not given. These mean values from multiple studies of these three species were were 83 percent, 73 percent, and 57 percent, respectively (Barclay and others, 2004). Nonreproductive female long-eared myotis are known to seek cooler shelters and utilize torpor more in summer than reproductive females (Solick and Barclay, 2006), and if nonreproductive long-eared myotis select higher, cooler sites at Mesa Verde, such behavior might account for the low reproductive rate in our sample of this species. It may also apply to the California myotis and western small-footed myotis. Similar findings have also been suggested by another study that included piñon-juniper habitat. Reproductive female bats of at least five species in common with Mesa Verde (big brown bats, western small-footed myotis or California myotis, long-eared myotis, long-legged myotis, and fringed myotis) were captured at higher rates in lower elevations than in higher elevations in west-central New Mexico (Chung-MacCoubrey, 2005). Low reproduction rates and elevational constraints probably also account for the low number of volant juvenile bats we captured in 2006. Some of our sampling sites at Mesa Verde (table III.2) were at elevations that may be higher than that favorable for nursery colony locations for several species. If some nonreproductive females act similarly to males and select cooler upper elevations in summer, then we would expect that bias to result in lower reproductive rates in the total sample of adult female bats taken at the principal netting sites. This explanation suggests that the higher elevation zones at the park are not favorable for maternity colonies for most species, and it is consistent with adult sex ratios favoring males in most species (9 of 15, table III.2) captured at our netting sites. It is also consistent with the movements of radiotagged reproductive adult females of some species to roosts at elevations lower than the capture sites (see Cryan, Section IV, this report).

The findings from the first field season suggest the hypothesis that bat reproduction at Mesa Verde is limited by the generally cooler, high elevations of the mesa tops, which results in a preponderance of adult males and nonreproductive females in several of the species we captured. This hypothesis is consistent with the literature on elevational distributions of the sexes of insectivorous bats in the Western

United States. An alternative hypothesis is that drought conditions in 2005 and spring 2006 resulted in lowered reproductive rates in 2006. If this hypothesis is true, then we would predict that our sampling in 2007 may yield higher reproductive rates, particularly if spring weather in 2007 includes significant moisture. (Precipitation enhances primary productivity and subsequent consumer insect abundance). We examined records of bats captured in the 1989–1994 USFWS surveys from the MSB database for indications of differences with our 2006 results in sex ratios or reproductive rates. For most species in common between the two surveys low sample sizes precluded comparisons. However, as detailed in the Results section above, there was no strong evidence for appreciably higher reproductive rates or abundance of volant juveniles in the earlier study. The skew in sex ratios also did not appear to differ between the two studies, with the exception of a shifting from a preponderance of female long-eared myotis in the USFWS survey to a preponderance of males in 2006. It is possible that the prolonged drought and fires over the past decade may have had an impact on this species.

A comparison of other results between the two surveys showed that all 11 species found in 1989–1994 were also among the 15 species we found in 2006. The relative abundance among species was somewhat different between the two surveys, which may in part reflect biases resulting from different choices of sites for netting bats. The prior surveys sampled over smaller pools that did not exist for sampling in the 2006 survey. These small pools may be avoided by the less maneuverable, faster flying species. Such species were probably more easily captured in 2006, when our sampling was concentrated around the large, open sewage lagoons. Netting bats at smaller pools may instead produce higher numbers and relative abundance of very maneuverable species that can easily drink at smaller sites, such as the long-eared myotis and Townsend's big-eared bat that were more dominant in the 1989–1994 survey. Alternatively, these shifts in proportions may reflect true changes in relative abundance, though to an unknown degree. Evidence for a change in relative abundance seems strongest in the case of the long-eared myotis. It was the most abundant species in the earlier surveys and also appeared to show a dramatic shift in sex ratios. However, the relative proportions of total captures by species are otherwise not radically dissimilar between the two surveys when results are limited to Morefield Canyon sites. The proportional rankings of the three most abundant species remained the same, although at the Morefield sewage lagoon the proportion of long-legged myotis declined with an increase in the occult myotis and the less maneuverable silver-haired bat. Overall, the evidence for reproduction, presence of juveniles, and sex ratios were also roughly comparable among species in the two studies.

The rankings of species abundance based on captures in mist-nets in 2006 do not follow the combined rankings of species or species groups by echolocation activity at the four activity monitoring stations (Ellison, Section V, this report). Each method has different biases, and perhaps the most clear-cut difference is in the abundance of species in the "low-frequency group" as defined by Ellison (Section V, this report). Brazilian free-tailed bats, for example, were recorded more than any other species in both echolocation passes and "feeding buzzes," yet constituted less than 1 percent of all bats captured in mist nets. This infrequency of capture is despite their being one of the least maneuverable and easily captured species of bat in the southwest. The seeming discrepancy can probably be explained by the fact that their calls can be very intense (of high amplitude) and can carry for longer distances than many other species. That is, the high instance of echolocation recordings does not necessarily indicate a large local population. Such considerations as well as other difficulties in interpretation of echolocation activity data prompt us to recommend using the capture-based data as the primary index of relative abundance of bats at Mesa Verde. However, biases such as maneuverability and foraging height should also be born in mind when considering relative rankings of species based on captures in mist-nets.

Recommendations

1. Continue to sample and accrue information on species composition, age, and sex of bats at Mesa Verde in 2007. Records from 2006 have generated a series of related hypotheses that can be subject to statistical analyses based on an additional summer of sampling. These hypotheses are (1) that sex biases occur in abundance of some common species, and (2) that elevation may account for some of these differences. The higher elevations associated with the northern parts of the mesa where much of our netting takes place may be marginal habitat for reproduction in females of some species.

2. Increase sampling at sites at lower elevations near and within Mesa Verde during the maternity period. Increased sampling would provide additional data that could be used (1) to test the hypothesis of an elevational bias against reproduction suggested by the 2006 surveys, and (2) to determine if species found to be less common at the sewage lagoons have greater representation at lower elevations. Include sites sampled in past surveys by the USFWS (for example, Limey Draw) and by Anderson (1961; for example, near Square Tower House). Repeat sampling at the tunnel under Cliff Palace.

3. Continue to determine reproductive status of adult female bats by mist-netting intensively during the maternity period as defined during the 2006 survey. Compare reproductive rates within species between the sampling years to determine if rates are generally low, thus consistent with a hypothesis of marginal habitat quality for reproduction at higher elevations in Mesa Verde. If reproductive rates show an increase, a more consistent hypothesis may be that

drought conditions in prior months caused lowered rates in summer 2006 and that more favorable conditions in 2006 and perhaps spring 2007 will result in an increase in reproductive rates.

4. Continue to sample bats for ectoparasites and coronaviruses opportunistically, and expand sampling of fecal pellets to include sampling by swabbing the rectal area of individual bats.

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Table III.1. Geographical characteristics of sites at Mesa Verde National Park where bats were captured and released for this study. Sites are listed from lowest to highest elevation. Longitude and latitude are in UTM. Long = longitude, Lat = latitude, T=township, R = range, S = section, Elev= elevation.

Capture site	Long	Lat	T	R	Sec	¼	Elev (ft)	Elev (m)
Mancos River	734586	4125157	34N	14W	35	NE	6,360	1,939
Cliff Palace Tunnel	724412	4116134	34N	15W	28	NE	6,780	2,067
Cedar Tree Sewage Lagoon	723204	4119490	34N	15W	16	NW	7,100	2,165
Pump Station Park Entrance	728739	4134756	36N	14W	32	SW	7,100	2,165
Wetherill Sewage Lagoon	719103	4118756	34N	16W	13	SE	7,100	2,165
Morefield Sewage Lagoon	729092	4128479	35N	14W	20	SE	7,580	2,311
Far View Sewage Lagoon	722669	4126030	35N	15W	27	SE	7,745	2,361
Far View Visitor Center	721940	4126169	35N	15W	27	SW	8,120	2,476

Table III.2. Scientific names, species abbreviations, and common names of bats captured at Mesa Verde National Park, 2006. Total bats captured (N), overall sex ratios of adults (males: females or M:F), evidence for reproduction (Repro) in females (Y = yes, N = no), and numbers of juveniles captured (N) are also given for all capture records at all sites combined.

Species	Abbrev	Common name	N captured	M:F	Repro	N juvs	N age or sex unk
Antrozous pallidus	ANPA	Pallid bat	1	1:0	N	0	0
Corynorhinus townsendii[1]	COTO	Townsend's big-eared bat	6	0.5:1	Y	0	0
Eptesicus fuscus	EPFU	Big brown bat	85	13:1	N	0	0
Euderma maculatum	EUMA	Spotted bat	4	0.3:1	Y	0	0
Lasiurus cinereus	LACI	Hoary bat	12	12:0	N	0	0
Lasionycteris noctivagans	LANO	Silver-haired bat	135	26:1	N	0	0
Myotis californicus	MYCA	California myotis	25	0.8:1	Y	0	0
Myotis ciliolabrum	MYCI	Western small-footed myotis	73	1.7:1	Y	0	0
Myotis evotis	MYEV	Long-eared myotis	137	1.3:1	Y	0	1
Myotis occultus[2]	MYOC	Occult myotis	60	0.7:1	Y	2	0
Myotis thysanodes	MYTH	Fringed myotis	19	1.7:1	Y	0	0
Myotis volans	MYVO	Long-legged myotis	322	0.3:1	Y	6	7
Myotis yumanensis	MYYU	Yuma myotis	7	1.3:1	Y	0	0
Parastrellus hesperus[3]	PAHE	Canyon bat	18	13:1	Y	3	1
Tadarida brasiliensis	TABR	Brazilian free-tailed bat	6	6:0	N	0	0
Unidentified *Myotis*			3	0.5:1		0	

[1] Formerly referred to as *Plecotus townsendii*; see Tumlinson and Douglas (1992) and Bogdanowicz and others (1998).

[2] Formerly referred to as *Myotis lucifugus occultus*; see Piaggio and others (2002).

[3] Formerly referred to as *Pipistrellus hesperus*; see Hoofer and others (2006).

Table III.3. Summary of distribution of effort (nights netted) by site and month. Sites are also categorized as lower and higher elevation sites.

Location	Nights Netted					No. Species	No. Bats	Bats/ night
	May	June	July	Aug	Total Nights			
1. Cedar Tree Tower S.L.	2	3	7	5	17	14	265	16
2. Cliff Palace Tunnel	0	0	1	0	1	5	72	
3. Wetherill S.L.	0	1	0	0	1	6	16	
4. Pump Station at entrance	1	0	0	0	1	2	3	
5. Mancos River	0	0	1	0	1	3	9	
6. Morefield S.L.	4	5	5	3	17	10	233	14
7. Far View S.L.	3	7	4	5	19	14	313	16
8. Far View Visitor Center		1	1	0	2	2	2	1
Total	10	17	19	11	58[1]	15	913	
Lower sites (1–5, ≤ 2,165 m)	3	4	9	5	21		365	17
Higher sites (6–8, ≥ 2,311 m)	7	13	9	8	37		548	15

[1] Two sites were netted on the same night.

Table III.4. Number of adult male and adult female bats captured at each netting site at Mesa Verde National Park, 2006. Few (11) juvenile bats were captured, 3 bats were not identified to species, and 8 bats did not have sex or age determined. These numbers are omitted from the table. Note that level of effort differed between lower and higher elevation netting sites, with more nights spent sampling at higher sites (see table III.3).

Species	**Cedar Tree SL**		**Wetherill SL**		**Mancos River**		**Pump Sta**		**Cliff Pal Tunnel**		**Far View SL**		**Morefield SL**		**FarView VC**		**Low sites**		**High Sites**	
	M	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***	***M***	***F***
Antrozous pallidus	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Corynorhinus townsendii	0	3	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	3	1	1
Eptesicus fuscus	38	2	3	0	4	0	0	0	0	0	28	0	1	2	5	2	45	2	34	4
Euderma maculatum	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	2
Lasiurus cinereus	6	0	1	0	0	0	0	0	0	0	1	0	4	0	0	0	7	0	5	0
Lasionycteris noctivagans	32	1	1	0	0	0	0	0	0	0	55	2	42	2	0	0	33	1	97	4
Myotis californicus	8	9	1	2	0	0	0	0	1	1	1	1	0	1	0	0	10	12	1	2
Myotis ciliolabrum	30	19	0	0	0	0	1	0	0	0	8	1	7	7	0	0	31	19	15	8
Myotis evotis	3	13	0	2	0	2	0	2	3	2	31	16	40	21	0	1	6	21	71	38
Myotis occultus	0	0	0	0	0	0	0	0	0	0	8	10	17	24	0	0	0	0	25	34
Myotis thysanodes	3	3	0	0	0	0	0	0	0	1	2	1	7	2	0	0	3	4	9	3
Myotis volans	21	44	1	5	1	1	0	0	14	45	20	106	12	38	0	1	37	95	32	145
Myotis yumanensis	2	1	0	0	0	0	0	0	0	0	2	2	0	0	0	0	2	1	2	2
Parastrellus hesperus	9	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	9	1	4	0
Tadarida brasiliensis	5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	1	0

Table III.5. Seasonal indices of bat capture activity at the three principal netting sites, Mesa Verde National Park, 2006.

Location and index	May	June	July	Aug
Cedar Tree Sewage Lagoon				
N Nights	2	3	7	5
N Bats Caught	17	128	98	22
N Bats per Night (range)	8.5 (3–14)	43 (20–83)	14 (4–27)	4 (2–7)
N Species	6	14	12	8
Morefield Sewage Lagoon				
N Nights	4	5	5	3
N Bats Caught	65	108	30	30
N Bats per Night (range)	16 (1–26)	22 (1–49)	6 (0–14)	10 (3–15)
N Species	6	7	9	7
Far View Sewage Lagoon				
N Nights	3	7	4	5
N Bats Caught	59	175	54	25
N Bats per Night (range)	20 (14–29)	25 (12–54)	13.5 (1–36)	5 (1–9)
N Species	8	13	6	5

Table III.6. Dates of capture of adult female bats at Mesa Verde National Park in 2006 according to stage of reproduction on the earliest and latest dates a bat was caught at each stage. These data have biases based on effort and location and are limited by small sample sizes for most species (see tables III.2 and III.3). They are intended to provide a rough indication of the season of reproductive activity for females of those species of bats that reproduce at or near Mesa Verde. Dashes indicate that no observations were made. Date of 1st juvenile = earliest date a volant juvenile was captured in flight.

Species	Date of 1st pregnant	Date of last pregnant	Date of 1st lactating	Date of last lactating	Date of 1st post-lactating	Date of 1st juvenile
Corynorhinus townsendii	--	--	July 7	July 7	--	--
Euderma maculatum	June 27	June 27	June 30	July 20	--	--
Myotis californicus	June 22	June 24	July 11	July 26	--	--
Myotis ciliolabrum	June 24	June 24	July 16	July 26	July 11	--
Myotis evotis	June 22	June 30	June 30	July 26	July 14	--
Myotis occultus	June 23	June 26	July 15	July 15	--	August 8
Myotis thysanodes	--	--	July 12	July 26	--	--
Myotis volans	June 24	July 16	June 30	July 26	July 11	July 22
Myotis yumanensis	June 26	June 26	--	--	--	--
Parastrellus hesperus	--	--	--	--	August 7	July 26

Table III.7. Reproductive rates of adult female bats captured at Mesa Verde National Park between June 20 and July 26, 2006. Only species with sample sizes greater than 10 adult females are included. Reproductive rates are based on total bats diagnosed as pregnant, lactating, or post-lactating as a proportion of all adult females sampled and diagnosed during the time period.

Species	N adult females	N pregnant	N lactating	N post-lactating	repro rate
Myotis californicus	11	3	4	0	64 %
Myotis ciliolabrum	17	1	3	2	35 %
Myotis evotis	27	2	7	3	44 %
Myotis volans	150	21	21	8	33 %

Table III.8. Numbers of reproductive females (number of total that were postlactating in parentheses) of each species of bat found in reproductive condition that were captured at each netting location in Mesa Verde National Park on any date in 2006. Combined totals are given for higher elevation sites (≥ 2,311 m) and lower elevation sites (≤ 2,165 m). Note that despite greater netting efforts and greater numbers of bats captured at higher elevation sites (see table III.3), most of the reproductively active female bats were captured at the lower elevation sites. Notable exceptions were the long-eared myotis (*Myotis evotis*, MYEV) and the long-legged myotis (*Myotis volans*, MYVO), which were detected equally at both elevation categories. Records for the pump station near the park entrance are excluded (sampling was too early to determine reproductive condition). See table III.2 for explanation of species abbreviations.

Species	Total Repro	Low sites	High sites	Cliff Pal Tunnel	Cedar Tree SL	Weth-erill SL	Mancos River	More-field SL	Far View SL	Far View VC
COTO	1	1	0	0	1	0	0	0	0	0
EUMA	3	1	2	0	1	0	0	1	1	0
MYCA	7	6	1	0	4	2	0	1	0	0
MYCI	6	5 (2)	1	0	5 (2)	0	0	1	--	0
MYEV	12	6 (1)	6 (2)	0	4 (1)	1	1	1 (1)	4 (1)	1
MYOC	8	0	8	0	0	0	0	4	4	0
MYTH	2	2	0	1	1	0	0	0	0	0
MYVO	52	26 (4)	26 (6)	15	11 (4)	0	0	6 (3)	19 (3)	1
MYYU	1	0	1	0	0	0	0	--	1	--
PAHE	1	1 (1)	0	0	1 (1)	0	0	0	0	0

Table III.9. Adult sex ratios of four species of myotis bats in June and July 2006 at all higher and lower elevation capture sites, Mesa Verde National Park. See table III.2 for explanation of species abbreviations.

Species	Lower Sites				Higher Sites			
	June		July		June		July	
	F	*M*	*F*	*M*	*F*	*M*	*F*	*M*
MYCA	6	2	5	5	1	1	0	0
MYCI	10	23	7	7	4	5	0	4
MYEV	4	3	13	3	17	32	6	15
MYVO	25	11	62	27	93	23	29	6

Table III.10. Total bats captured, overall sex ratios of adults (M:F), evidence for reproduction in females (Y= yes, N = no), and numbers of juveniles captured in 2006 in comparison with all specimen records in the Museum of Southwestern Biology (MSB) at all sites combined for 1989–1994 U.S. Fish and Wildlife Service survey of bats at Mesa Verde National Park.

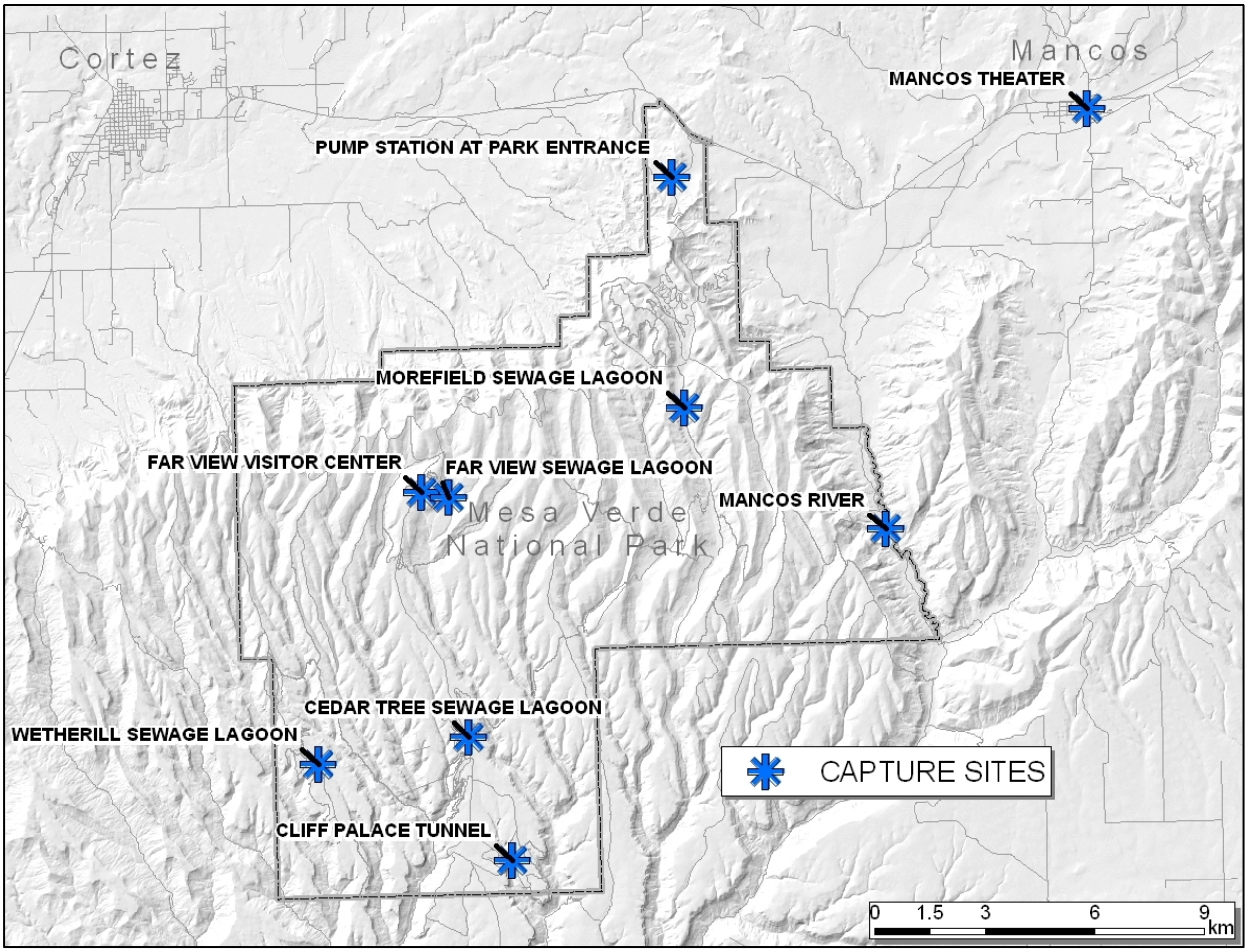
Species	2006 N bats	MSB N bats	2006 M:F	MSB M:F	2006 repro	MSB repro	2006 N juvs	MSB N juvs
Antrozous pallidus	1	1	1:0	0:1	N	N	0	0
Corynorhinus townsendii[1]	6	20	0.5:1	0.05:1	Y	Y	0	0
Eptesicus fuscus	85	2	13:1	2:1	N	N	0	0
Euderma maculatum	4	0	0.3:1	0:0	Y	N	0	0
Lasiurus cinereus	12	1	12:0	1:0	N	N	0	0
Lasionycteris noctivagans	135	6	26:1	6:0	N	N	0	0
Myotis californicus	25	9	0.8:1	0.8:1	Y	Y	0	0
Myotis ciliolabrum	73	4	1.7:1	3:1	Y	N	0	0
Myotis evotis	137	71	1.3:1	0.5:1	Y	Y	0	1
Myotis occultus[2]	60	1	0.7:1	1:0	Y	N	2	0
Myotis thysanodes	19	9	1.7:1	0.5:1	Y	N	0	0
Myotis volans	322	53	0.3:1	0.4:1	Y	Y	6	7
Myotis yumanensis	7	0	1.3:1	0:0	Y	N	0	0
Parastrellus hesperus[3]	18	0	13:1	0:0	Y	N	3	0
Tadarida brasiliensis	6	0	6:0	0:0	N	N	0	0
Unidentified *Myotis*	3		0.5:1				0	

[1] Formerly referred to as *Plecotus townsendii*; see Tumlinson and Douglas (1992) and Bogdanowicz and others (1998).

[2] Formerly referred to as *Myotis lucifugus occultus*; see Piaggio and others (2002).

[3] Formerly referred to as *Pipistrellus Hesperus*; see Hoofer and others (2006). We use the common name "canyon bat" in this report rather than "western pipistrelle."

Figure III.1. Sites at which bats were captured during the spring and summer of 2006 at Mesa Verde National Park and surrounding areas, Montezuma County, Colo.



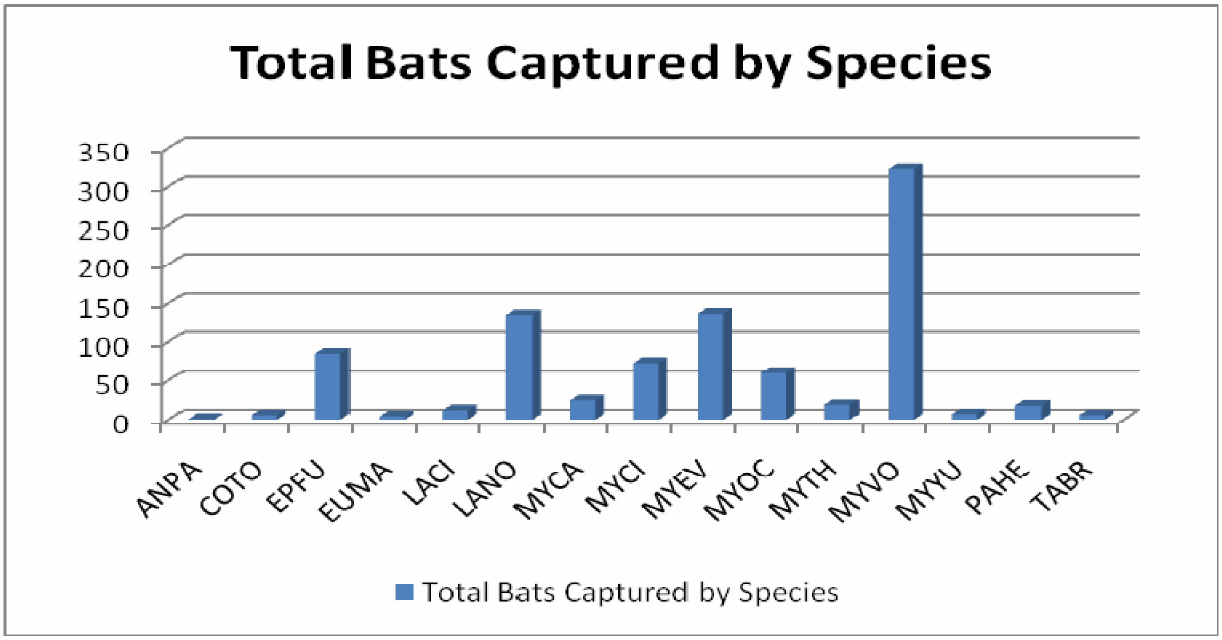


Figure III.2. Total bats captured by species at Mesa Verde National Park, May–August 2006. Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, ANPA = *Antrozous pallidus*; see table III.2 for full list).

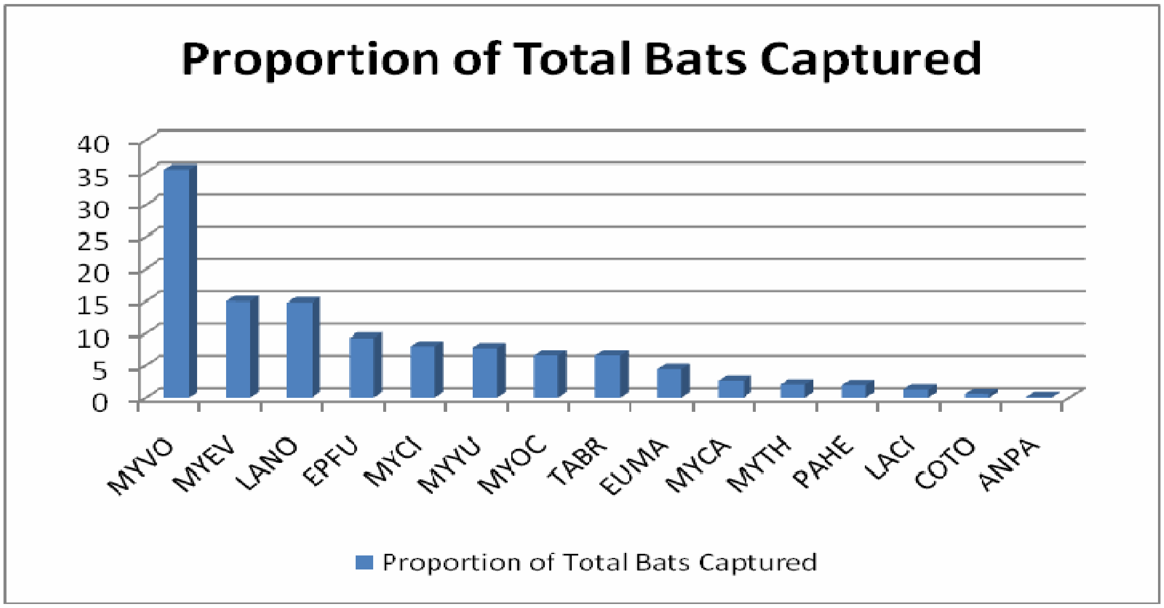


Figure III.3. Proportion of total bats captured by species at Mesa Verde National Park, May–August 2006 (total captures = 910 bats identified to species). Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, ANPA = *Antrozous pallidus;* see table III.2 for full list).

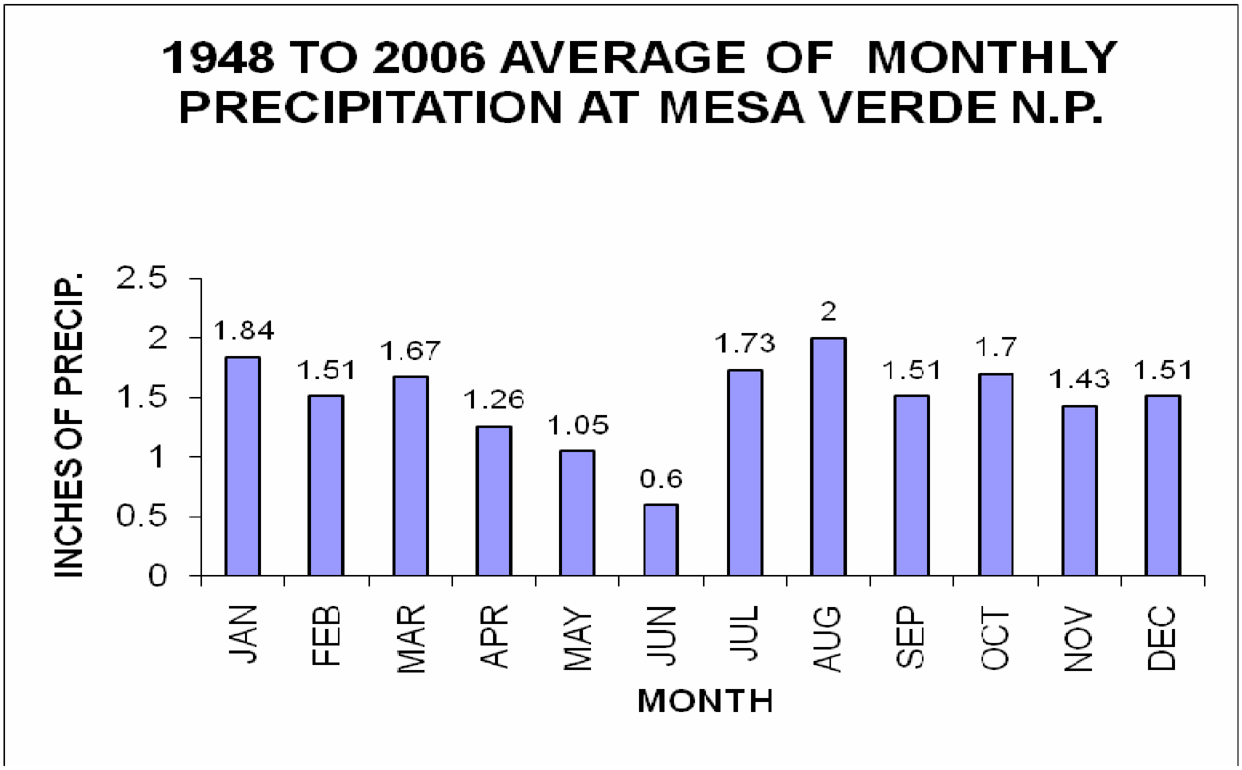


Figure III.4. Mean monthly precipitation at Mesa Verde National Park, 1948–2006. (Based on data available from Western Regional Climate Center [2006]).

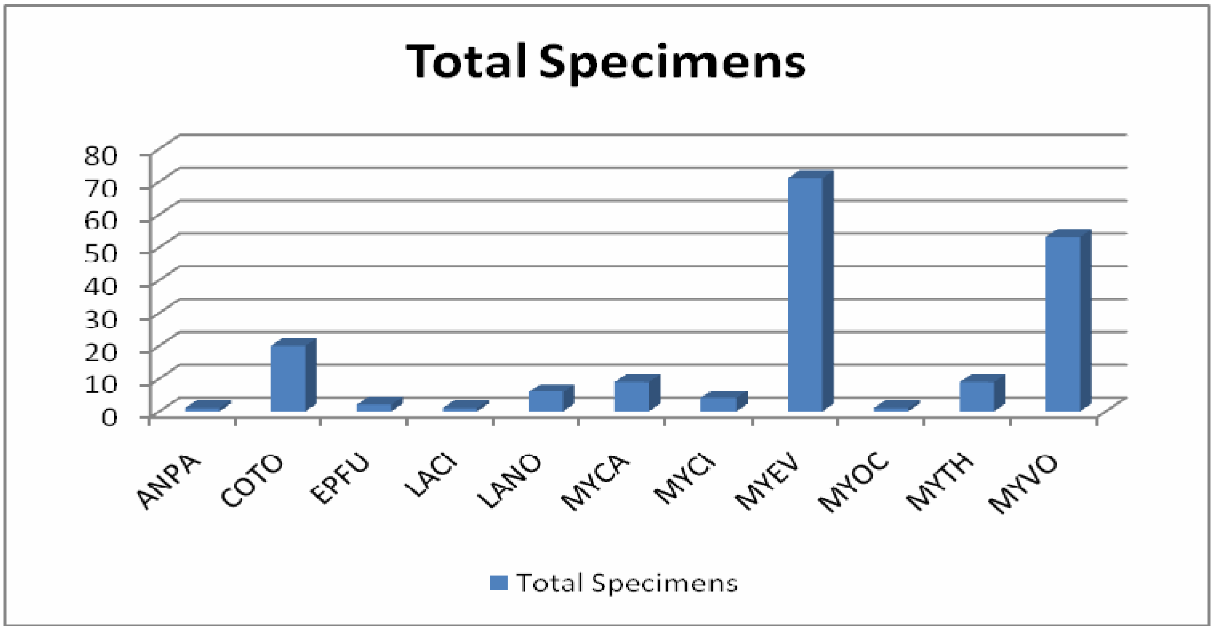


Figure III.5. Total numbers of specimens taken at Mesa Verde National Park during U.S. Fish and Wildlife Service surveys in 1989–1994. Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, ANPA = *Antrozous pallidus*; see table III.2 for full list).

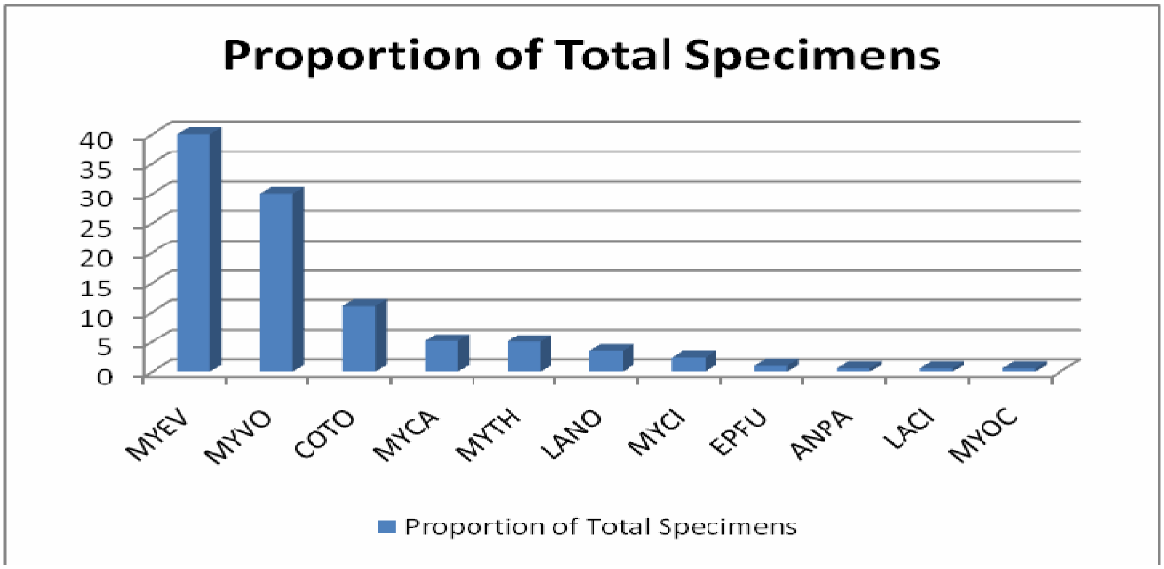


Figure III.6. Proportion of total bat specimens per species from U.S. Fish and Wildlife Service surveys of bats at Mesa Verde National Park, 1989–94 (total specimens = 177 bats, in the database of the Museum of Southwestern Biology). Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, ANPA = *Antrozous pallidus*; see table III.2 for full list).

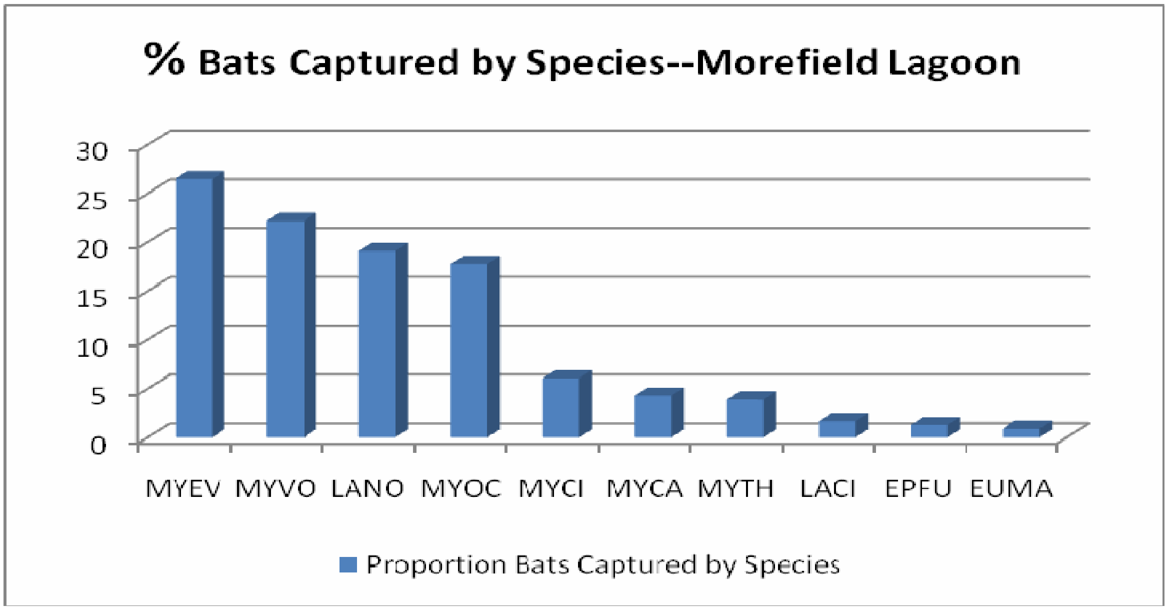


Figure III.7. Proportion of total bats captured by species at the Morefield Sewage Lagoon, Mesa Verde National Park, 2006. Total bats captured at this site in 2006 = 230. Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, MYEV = *Myotis evotis*; see table III.2 for full list).

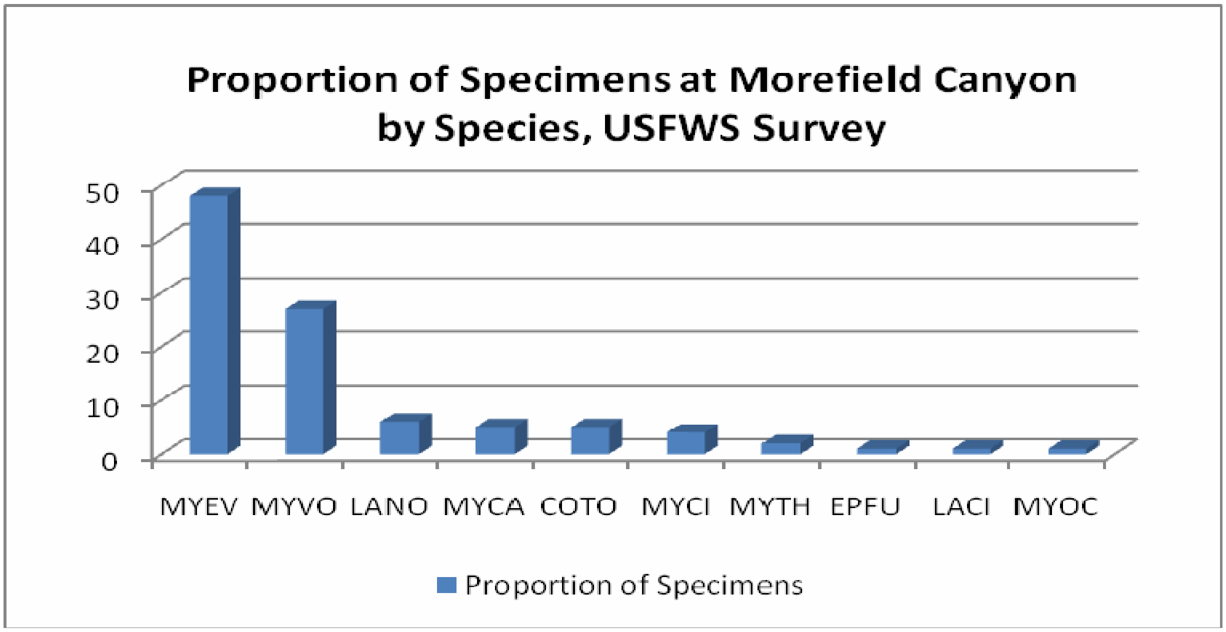


Figure III.8. Proportion of total bat specimens per species from U.S. Fish and Wildlife Service surveys of bats at Morefield Canyon, 1989–94 (total specimens = 85 bats, in the database of the Museum of Southwestern Biology). Species abbreviations are based on the first two letters of the genus and first two letters of the specific epithet for each species (for example, MYEV = *Myotis evotis*; see table III.2 for full list).

IV. Radiotracking Bats to Roosts and Roost Site Habitat Characteristics

By Paul M. Cryan

Introduction

Previous information on bats at Mesa Verde and roosting habits of bats in piñon-juniper woodlands is limited (Chung-MacCoubrey and Bogan, 2003), and no published information exists on bat use of forests of any type based on fire history (Fisher and Wilkinson, 2005). All of the species of bats currently known to roost in trees in piñon-juniper woodlands of the Southwestern United States can be expected to occur at Mesa Verde. The only previous study to examine bat use of piñon-juniper woodlands took place in the Gallinas and San Mateo Mountains of New Mexico, where reproductive female bats roosted in ponderosa pine, piñon pine, juniper, and rocks, and bats moved among more than one roost frequently (Chung-MacCoubrey, 2003a, 2003b). In junipers bats roosted in crevices and cavities of part-dead, part-live trees. In piñon pines bats roosted under bark in snags of early stages of decay, and in ponderosa pines bats roosted in large vertical cracks in trunks (Chung-MacCoubrey, 2003a). In the New Mexico study, bats appeared to be more abundant, and a greater proportion of females showed evidence of reproduction in the piñon-juniper woodlands than in ponderosa pine forests (Chung-MacCoubrey, 2005). One of our study objectives during 2006 was to follow bats tagged with radio transmitters to determine the specific types of roosts used by species occurring at Mesa Verde. The specific focus of this work was to assess the potential for old-growth piñon-juniper forests on the park to provide roosting habitat for bats and to determine the influence of fire on roost use by bats inhabiting such forests.

Methods

Select bats were marked for tracking using miniature radio transmitters tuned to a frequency of 164 mHz (Holohil Systems Ltd., Woodlawn, Ontario; Blackburn Transmitters, Nacogdoches, Tex.). We focused our tracking efforts on reproductive females in order to find maternity colonies. Transmitters weighed 0.32– 0.78 g and were deployed on bats only when the transmitter weighed less than 5 percent of the bat's body mass (Aldridge and Brigham, 1988). Transmitters were attached to the mid-scapular region of the dorsal pelage using surgical adhesive (Skin-Bond, Smith & Nephew, Largo, Fla.) after trimming a small patch of fur to within 1 mm of the skin. To ensure adhesion, bats were held for 30 minutes after transmitter attachment.

We tracked the signals from radiotagged bats during the day in order to find their roosts. We did not attempt to follow the nighttime movements of bats, except on rare occasions when we were trying to determine the whereabouts of day roosts. We used scanning telemetry receivers (R-1000, Communication Specialists, Inc., Orange, Calif.) and monitored for signals of tagged bats from vehicles equipped with roof-mounted telemetry antennae (5-element yagi) and on foot using portable antennae (3-element, collapsible yagi). When the radio signal of a tagged bat was detected, we homed in on it and tried to determine the exact location of the roosting bat. In many cases, we were prevented from getting close to the origin of the transmitter signal because of cliffs and inaccessible canyons. When we could not get close (<5 m) to the roost of a tagged bat we took multiple bearings on the signal from different places and estimated its location by triangulation. We attempted to locate tagged bats on a daily basis for the life of each radio transmitter (approx. 8–14 days).

Upon finding a bat roost we recorded the structure type (building, rock crevice, tree), took quantitative measures of the roost when possible (for example, entrance dimensions, height above ground, species and size of tree), and recorded measures of the roost landscape (for example, density and species composition of surrounding vegetation, orientation of roost). Detailed data on landscape and roost characteristics were gathered by E. Apple Snider and will be analyzed and presented as part of her master's thesis. We will not report on those aspects of the project in this report.

When practical, we sat outside of bat roosts at dusk and counted the number of bats seen emerging. When observing emergence flights at roosts of *E. maculatum* we also counted the number of individuals heard making audible calls as they left roost crevices. We assumed but could not confirm that separate series of calls were from different individuals.

Results

During the spring and summer of 2006, we tagged a total of 36 bats of 7 different species with radio transmitters (table IV.1; appendix IV.1). Most of the bats we tagged (78 percent) belonged to three species: long-eared myotis (*Myotis evotis*), long-legged myotis (*M. volans*), and occult myotis (*M. occultus*). We tagged three or fewer individuals of the four other species (fringed myotis [*M. thysanodes*], Yuma myotis [*M. yumanensis*], Townsend's big-eared bats [*C. townsendii*], and spotted bats [*E. maculatum*]). We did not tag California myotis (*M. californicus*) or western small-footed myotis (*M. ciliolabrum*) because body mass of individuals we captured was never above the threshold of weight (7 g) necessary for carrying our smallest transmitters. Only half of the bats we tagged were subsequently located in roosts (table IV.1). We were most successful in finding the general roost locations of spotted bats (100 percent; *n*=3), occult myotis (80 percent; *n*=4), long-legged myotis (63 percent; *n*=6), and long-eared myotis (43 percent; *n*=6). We were unable to find any daytime roosts of the Yuma myotis or Townsend's big-eared bats that we tagged. We detected the signal of one of the fringed myotis that we tagged, but we were unable to localize it because it roosted in a high, inaccessible cliff face in the wall of Soda Canyon. We suspect that many of the bats we did not find were roosting within rock crevices or caves in remote areas of the park that were less than about 1–2 km from access roads, which was the approximate distance at which we regularly detected bats in such roosts. In general, long-eared myotis switched between roosts rather frequently, with an average of 4.6 roosts discovered per bat followed. Our observations suggest that other species switched roosts less frequently, with ≤2 roosts found or suspected per bat. The distribution of roosts found for each species is shown in figure IV.1. Roosts of long-eared myotis were found throughout the study area. Roosts of occult myotis were found in Morefield Canyon and in the Mancos River Valley. Roosts of long-legged myotis were mostly found in steep-walled canyons on the southern end of the park, as were those of spotted bats. We were able to determine the precise location of one of the roosts used by spotted bats in the Echo Cliff on the south end of the park. Reproductive female bats (that is, those bats pregnant and lactating) were found roosting in all parts of the study area (fig. IV.2) and there was a slight trend toward pregnant females roosting at lower elevations in the Mancos Valley (occult myotis) and on the southern end of the park (long-legged myotis and spotted bats). We found bats roosting in a variety of structures (fig. IV.3). We found long-legged myotis and spotted bats roosting exclusively in rock crevices within steep canyon slopes and cliff faces. We were unable to determine the roost structure of one of the long-legged myotis that we tracked because the transmitter failed before we were able to establish its precise location (question mark in fig. IV.3). However, based on the properties of the radio signal (that is, attenuation and directionality), we suspect the bat was within a rock crevice. A pregnant female occult myotis that we tagged in mid-June at the sewage lagoon in Morefield Canyon moved between a building in the Mancos Valley and a rock crevice and ponderosa pine snag in Morefield Canyon during the period that we followed her. All other female occult myotis that we tagged were found roosting in buildings in the Mancos Valley. One female long-eared myotis tagged in mid-June at the sewage lagoon in Morefield Canyon was found on Bureau of Land Management land north of the park roosting in juniper snags, downed logs, and live trees. All (*n*=5) of the other female long-eared myotis that we followed were found roosting in rock crevices, often close to the ground. Figure IV.4 shows the locations of roosts in relation to where bats were initially tagged.

With the exceptions of the sewage lagoon near Cedar Tree Tower, the tunnel beneath Cliff Palace (a drinking site near a maternity colony), and the Far View Visitor Center (a night roost), bats regularly traveled more than 10 km between their capture site and subsequent roosts (fig. IV.4). Only three of the seven bats initially tagged at the sewage lagoon near Cedar Tree Tower were subsequently found (two long-legged myotis and one spotted bat), all in deep canyons on the southern end of the park. Overall, we were better able to access roost sites used by long-eared myotis and occult myotis because they were usually in rock crevices near the ground and in buildings, respectively. We had a harder time pinpointing roosts used by long-legged myotis and spotted bats because these species tended to roost in more inaccessible, steep-walled canyons near the southern end of the park. Patterns in the precision of roost locations are depicted in figure IV.5. Average distance moved by each species between capture site and roosts, as well as average elevation of roost sites, are shown in table IV.2. Raw distance and elevation data are provided in appendix IV.2.

Discussion

This work represents the first targeted research into the use of daytime roosts by bats at Mesa Verde National Park. Although radiotracking studies of this kind are labor intensive and apt to produce superficially disappointing results (for example, only 50 percent of tagged bats found), the knowledge gained is directly applicable to management of habitat for bats. Bats spend the majority of their time sequestered in day roosts and the availability of suitable roosts is a major factor influencing bat populations (Kunz, 1982). Developing a better understanding of the daytime roosting habits of bats at Mesa Verde is an important step toward ensuring their well-being in the park. Several of our tracking results, detailed in the species accounts that follow, were unanticipated and illustrate the fact that generalizations about the roosting habits of bats should be treated cautiously.

Myotis evotis.—Long-eared myotis are known to form summer colonies in buildings, trees, mines, and rock crevices (Manning and Jones, 1989; Cruszcz and Barclay, 2002; Chung-MacCoubrey, 2003a; Solick and Barclay, 2006). In this study, we found them roosting in both trees and rock crevices. Trees were used by only one individual, a female of unknown reproductive status tagged during mid-June. This bat may have been in the early stages of pregnancy, but it was too early for us to determine by palpation. This bat switched roosts on a near daily basis and roosted in both live and dead piñon and juniper trees. Two of the trees used as roosts were still alive, whereas three were snags or downed logs. All other roosts used by this species were in rock crevices. Long-eared myotis typically roosted in situations where they were within 1–2 meters of the ground and we could often see the bats inside the roosts. We rarely saw groups of more than two or three individuals within roosts. Bats roosting in rock crevices changed roosts frequently and were rarely observed using the same roost on multiple dates. Most of the roosts we found for this species were on the northern half of the park, although one roost was located in a large boulder in School Section Canyon near the confluence of Soda Canyon (fig. IV.1). Apple Snider and her crew collected detailed information on the characteristics of roosts and surrounding vegetation as part of her master's thesis project.

Myotis occultus.—In other parts of its range the occult myotis is known to form colonies in buildings, tree snags, and bridges (Stager, 1943; Hayward, 1963; Barbour and Davis, 1969; O'Farrell and Studier, 1975; Piaggio and others, 2002; Valdez, 2006). During 2006 we observed what might have been evidence of local habitat shifts by this species in the area around Mesa Verde (see also O'Shea and Valdez, Section III, this report). A female occult myotis that we presumed to be pregnant was initially tagged at the Morefield Canyon sewage lagoon on June 16. The next day we found her roosting in a building in the Mancos Valley. She roosted in the building for two subsequent days, then returned to Morefield Canyon and roosted in a rock crevice on June 20. The following day she returned to the building roost in the Mancos Valley and remained there for a few days before returning to Morefield Canyon on June 24 to roost in a ponderosa pine snag. After that date, all of the other pregnant female *M. occultus* we tagged at the sewage lagoon in Morefield Canyon (*n*=3) were subsequently found roosting in buildings in the Mancos Valley. We propose that female occult myotis may winter in rock crevices in Morefield Canyon and that the movements of the female tagged on June 16 may have been a transition from winter to summer quarters. Maternity roosts of occult myotis tagged in the park were found in several buildings in the Mancos Valley including private residences, the Hogan Trading Post on Highway 160 near Mancos, and the Old Mancos Theater. Emergence counts at buildings used by occult myotis in the Mancos Valley often revealed large colonies (numbering into the hundreds). Apple Snider oversaw most of the monitoring of roosts used by occult myotis in the Mancos Valley and will likely report those data as part of her master's thesis.

Myotis volans.—Long-legged myotis are known to form summer colonies in trees, rock crevices, and buildings (Warner and Czaplewski, 1984). Throughout their range long-legged myotis are associated with coniferous forests (Warner and Czaplewski, 1984; see also table III.4 in O'Shea and Valdez, Section III, this report) and are generally thought of as a forest bat by researchers familiar with the species. In northern regions, long-legged myotis are known to use rock crevices as daytime roosts but tend to roost in trees more frequently (Vonhof and Barclay, 1996; Ormsbee and McComb, 1998; Cryan and others, 2001; Baker and Lacki, 2006). Bogan and others (1998) tracked two lactating females of this species to a colony in a rock crevice in the Jemez Mountains of northern New Mexico. In piñon-juniper forests of the Southwest, Chung-MacCoubrey (2003a) tracked 19 reproductive females and found most of them forming colonies in piñon trees and snags. Piñon-juniper forests in the latter study were younger and less mature than many of those found at Mesa Verde (A. Chung-MacCoubrey, oral commun., 2006). Considering the age and size of many of the piñon and juniper trees at Mesa Verde (ample potential roosting opportunities for bats), combined with our collective experience and knowledge regarding the roosting behavior of long-legged myotis elsewhere, we were surprised that none of the individuals we tagged were found roosting in trees. All of the tagged long-legged myotis we were able to locate were roosting in rock crevices. Had any of those we tagged during 2006 been roosting in trees on the park during 2006, we suspect that we would have located them; radio signals emanating from trees on mesa tops would be much more detectable than those coming from within rock crevices in canyons. Although we did not watch emergences of long-legged myotis, we suspect that they formed large colonies for three reasons: (1) we tracked individuals tagged at different netting sites back to the same roosts; (2) we captured a large number of females shortly after sunset entering the tunnel beneath Cliff Palace (see O'Shea and Valdez, Section III, this report) near what we subsequently discovered to be a daytime roost occupied by at least three tagged bats; and (3) the signals of three different pregnant and lactating females tagged on June 26 and July 14 were heard suddenly at dusk (indicating emergence from a deep crevice or cave) coming from either Spruce or Navajo Canyon at a bearing of 300° from the fire tower near Cedar Tree Tower. The majority of long-legged myotis we located were found roosting in lower-elevation canyons (table IV.2) on the southern end of the park (fig. IV.1). It is unclear whether this pattern has something to do with proximity to the tagging site, a preference for roosts at lower elevations (see O'Shea and Valdez, Section III, this report) and(or) in deeper canyons, or other unknown reasons.

Euderma maculatum.—Spotted bats are known to roost in crevices within high cliff faces, but published studies are lacking (Watkins, 1977). Recently, Chambers and others (written commun., 2006) tracked spotted bats in northern Arizona and found them roosting in cliff faces of the Grand Canyon, but specific information about roosts (for example, configuration and number of bats in a colony) could not be gathered because of their inaccessibility. The most detailed information on the roosting habits of spotted bats comes from a study in the Jemez Mountains of northern New Mexico (Bogan and others, 1998). In that study, five spotted bats (two lactating females, one male, and two juvenile females) were tracked to roosts in rock crevices high on cliff walls. Emergence counts (based on audible echolocation calls) at roosts indicated that group size ranged between about 1 and 30 individuals. Although spotted bats occur across much of western North America, our observations from Mesa Verde substantially add to the few that have been previously reported. The first spotted bat captured on the park was a pregnant female. This bat, nicknamed "Scout" by the tracking crew, was captured at the sewage lagoon near Cedar Tree Tower on June 26 and was found the next day roosting next to the Echo Cliff of lower Navajo Canyon. We hiked into Navajo Canyon on June 28 and localized the signal to a series of crevices in the canyon wall about 10 m down canyon from the west margin of the main facet of Echo Cliff. This area of the cliff face is clearly visible from the Navajo Canyon Overlook, where it appears to be a large vertical column with white streaking down its left margin. We sat beneath the roost at sunset and at about 9:00 p.m. began hearing the audible echolocation calls of spotted bats as they flew from the roost. It was difficult to precisely determine how many spotted bats emerged from the roost because several that were already flying returned to and circled near the entrance as others were emerging. Our conservative estimate is that at least 8 individuals emerged and that as many as 19 may have been using the roost. We suspect that this roost was a maternity colony, composed mostly of female bats and their young. To the best of our knowledge, this study is only the second study (along with that of Bogan and others, 1998) to make direct observations of such a colony of spotted bats. The other two female spotted bats that we tagged were found using separate roosts in Rock Canyon, the first between Long House and Kodak House, and the second in Soda Canyon across from the Soda Canon Overlook. These latter roost sites were also in steep cliff faces and proved harder to access than the roost in Navajo Canyon. Logistical constraints prevented us from making direct observations at those sites. Spotted bats likely rely on the high cliffs found in canyons at the southern end of the park. This supposition is supported by the observation that individuals we tagged at the Far View and Morefield Canyon traveled more than 10 km to subsequently roost in lower Rock and Soda Canyons, respectively.

Many species of bats in western North America rely on rock crevices as roosting sites, but the extent of use and requisite characteristics of such sites are poorly understood (Bogan and others, 2003; Neubaum and others, 2006). In our study, we found three species of bats (long-eared myotis, long-legged myotis, and spotted bats) roosting mostly in rock crevices. Researchers working in other regions have also noted the predominant use of rock crevices by long-eared myotis and spotted bats. However, our findings of extensive use of rock crevices by long-legged myotis differ from results of most other studies on this species. Little is known about the roosting preferences of bats when both trees and rock crevices are available in a landscape, but our results from Mesa Verde (also see Cryan, Section VI, this report, for information on detector dogs) indicate that use of trees may not be extensive when rock crevice roosts are an abundant resource. Bats generally tend to show greater fidelity to roosts that are more permanent than those that are temporary (Lewis, 1995) and may thus prefer the more stable roost structures in rock over those in trees. However, the sample of long-legged myotis that we tracked during 2006 was relatively small and additional data are needed concerning this species before reasonable conclusions can be drawn. If bats are using piñon and juniper trees as roosts at Mesa Verde, then *M. volans* is the most likely bat to be doing so.

Recommendations

The work during 2006 revealed three promising directions for additional radiotracking. Overall, our success rate at finding tagged bats was approximately 50 percent, which is typical of ground-based telemetry efforts of this type (for example, Bogan and others, 1998; Cryan and others, 2001). This efficiency could be dramatically improved by employing an aircraft to find the initial locations of tagged bats. Our experience is that after initially locating the general roosting area of tagged bats, they rarely leave those general areas on subsequent days. At Bandelier National Monument and the Jemez Mountains of New Mexico, we used an aircraft to find the initial locations of tagged bats roosting in deep, rocky canyons that would have never been located by ground searches alone. The situation at Mesa Verde is similar and it is likely that many of the bats we tagged and lost during 2006 remained in the park but were in deep canyons that we could not monitor easily from roads. Thus, we recommend use of an aircraft to find the initial locations of bats tagged during the summer of 2007, followed by foot surveys to better pinpoint locations and estimate colony size. Capture surveys in 2006 (see O'Shea and others, Section III, this report) provided us with a clearer picture of the timing of reproduction by female bats on the park and will help us better time our tracking efforts and make maximum use of an aircraft.

Tracking during 2006 revealed important information about the roosting habits of three species on the park. The roosting habits of spotted bats are not well documented anywhere in North America and this species should be tagged and followed during 2007 whenever possible. Furthermore, our discovery of an important roost site visible from a public overlook (Navajo Canyon) gives the park the potential for bat-specific interpretative opportunities, especially in light of the spectacular and charismatic appearance of this bat. Information gained on the use of roosts by long-eared myotis on the park during 2006 was helpful in that it showed the use of trees by this species north of the park. Tracking of *M. evotis* should continue during 2007 to establish the possible use of trees as roosts at Mesa Verde. As discussed above, we expected long-legged myotis to use trees as roosts on the park but have not yet observed such behavior. Our sample of tagged long-legged myotis during 2006 was relatively small and we recommend focusing a considerable tracking effort on this species during the summer of 2007. Additional data are needed to rule out the possibility that long-legged myotis regularly take advantage of old growth piñon and juniper trees as roosts at Mesa Verde.

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Table IV.1. Number of female bats, by species and reproductive class, which were radiotagged during the spring and summer of 2006 at Mesa Verde National Park. Numbers in parentheses indicate the number of bats that were subsequently found after tagging.

Table IV.2. Average distance traveled by each bat species between initial capture locations and roosts (Avg. distance) and average elevation of roost sites (Avg. elevation). Distance error is ±1 km and elevation error is ±10 m.

Species	Avg. Distance ± SD (km)	Avg. Elevation ± SD (m)
Myotis evotis	3.2 ± 3.3	2219 ± 106
Myotis occultus	6.0 ± 4.2	2107 ± 122
Myotis volans	2.9 ± 2.7	2055 ± 113
Euderma maculatum	8.3 ± 4.0	1967 ± 71

Figure IV.1. Map of Mesa Verde National Park and surrounding areas showing the location of bat roosts, by species, discovered through radiotracking during the summer of 2006.

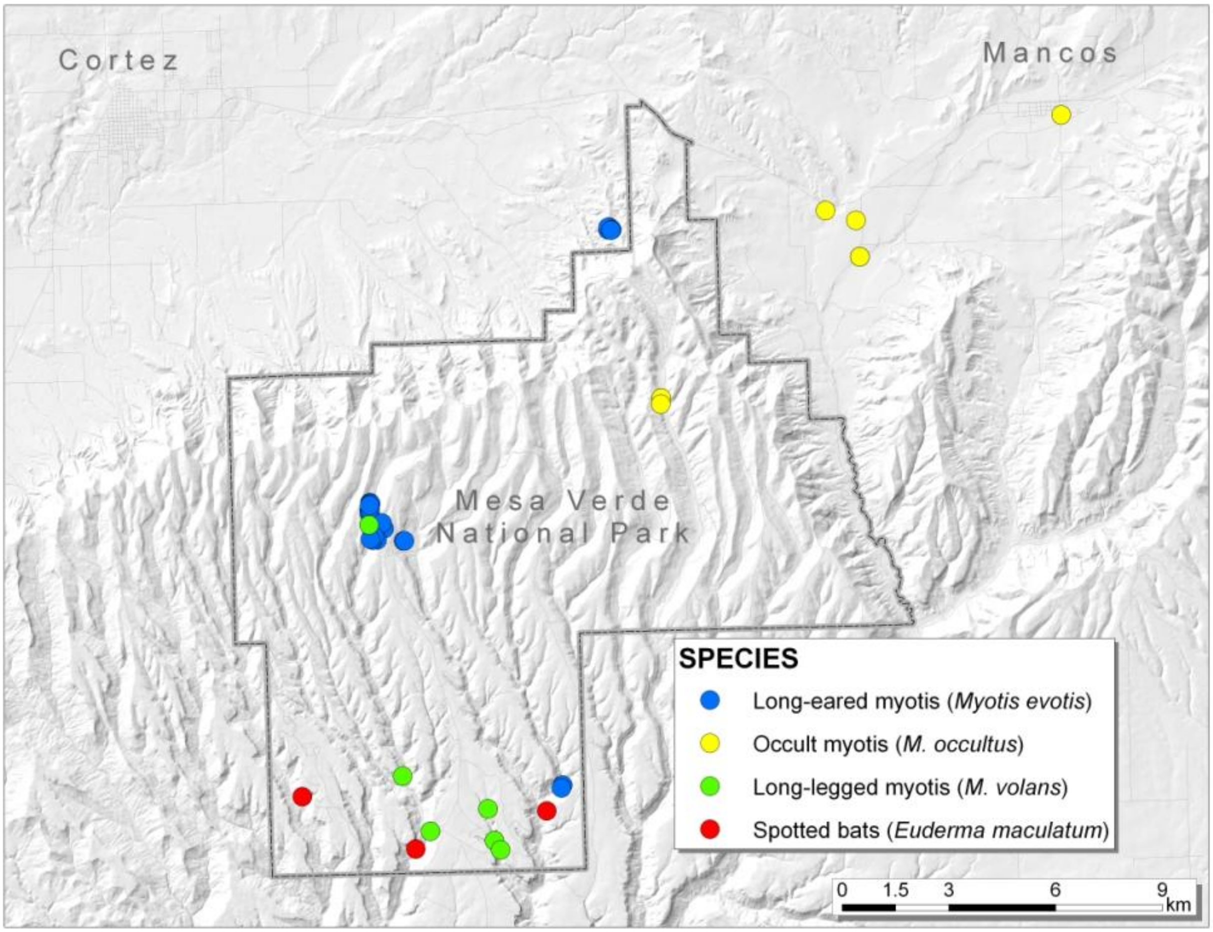


Figure IV.2. Map of Mesa Verde National Park and surrounding areas showing the location of bat roosts, by reproductive class, discovered through radiotracking during the summer of 2006. Bats captured early in the season before signs of pregnancy were apparent were classified as "unknown."

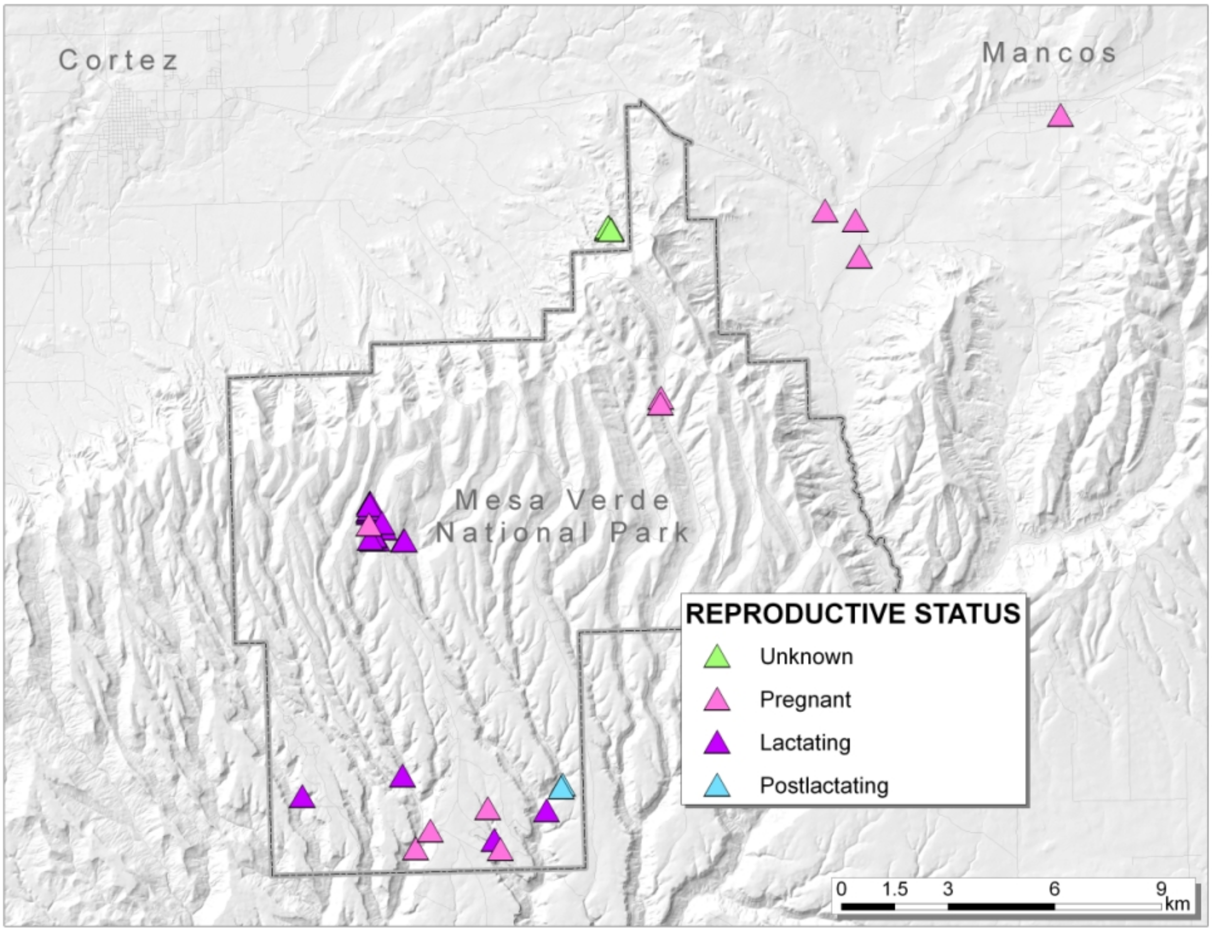


Figure IV.3. Map of Mesa Verde National Park and surrounding areas showing the location of bat roosts, by roost type, discovered through radiotracking during the summer of 2006. Roost types consisted of buildings (blue houses); live trees, snags, and downed logs (green stars); rock crevices in cliffs and boulders (red crosses); and structure types that were not established due to inaccessibility (question mark).

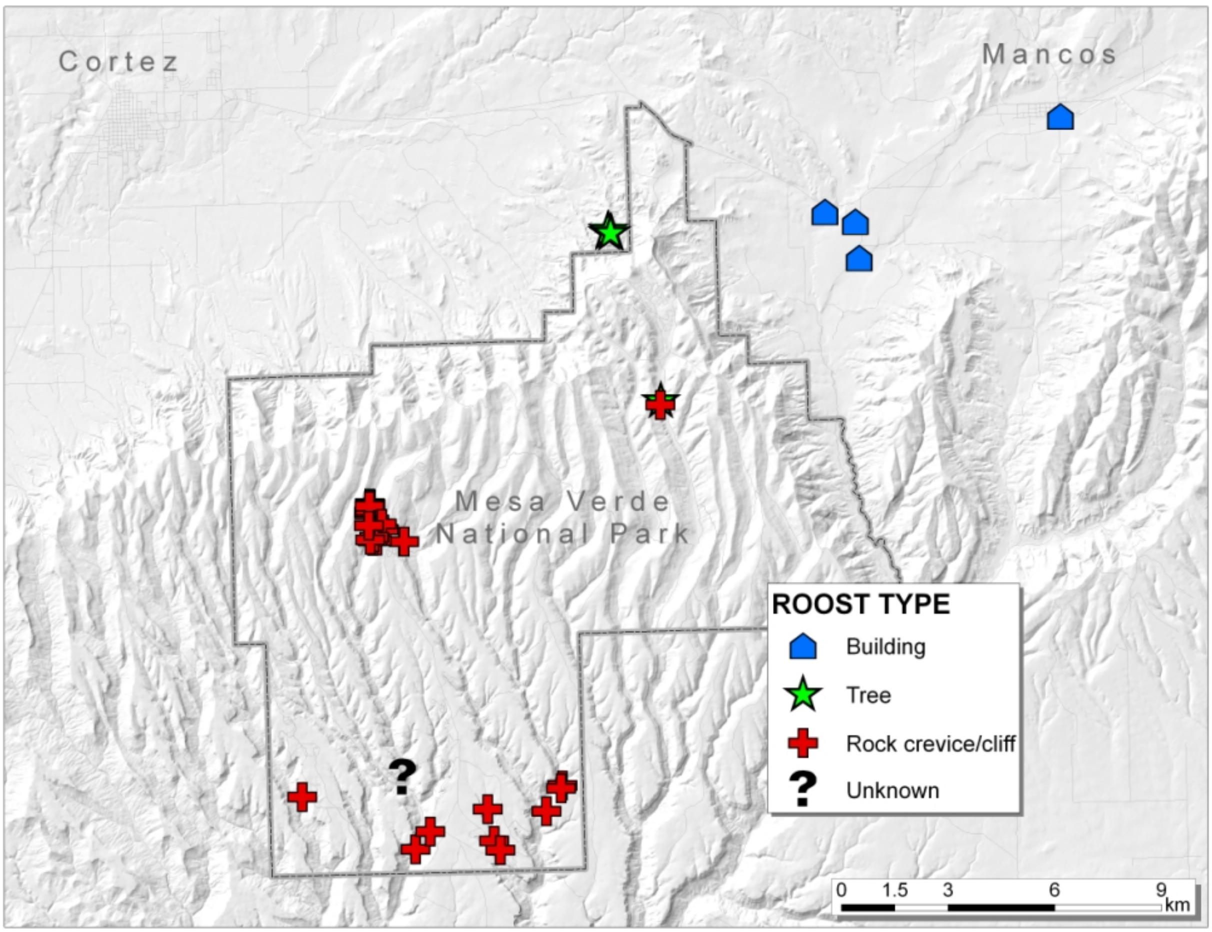


Figure IV.4. Map of Mesa Verde National Park and surrounding areas showing the location of bat roosts (colored diamonds), by tagging site, discovered through radiotracking during the summer of 2006. Netting sites shown with colored circles.

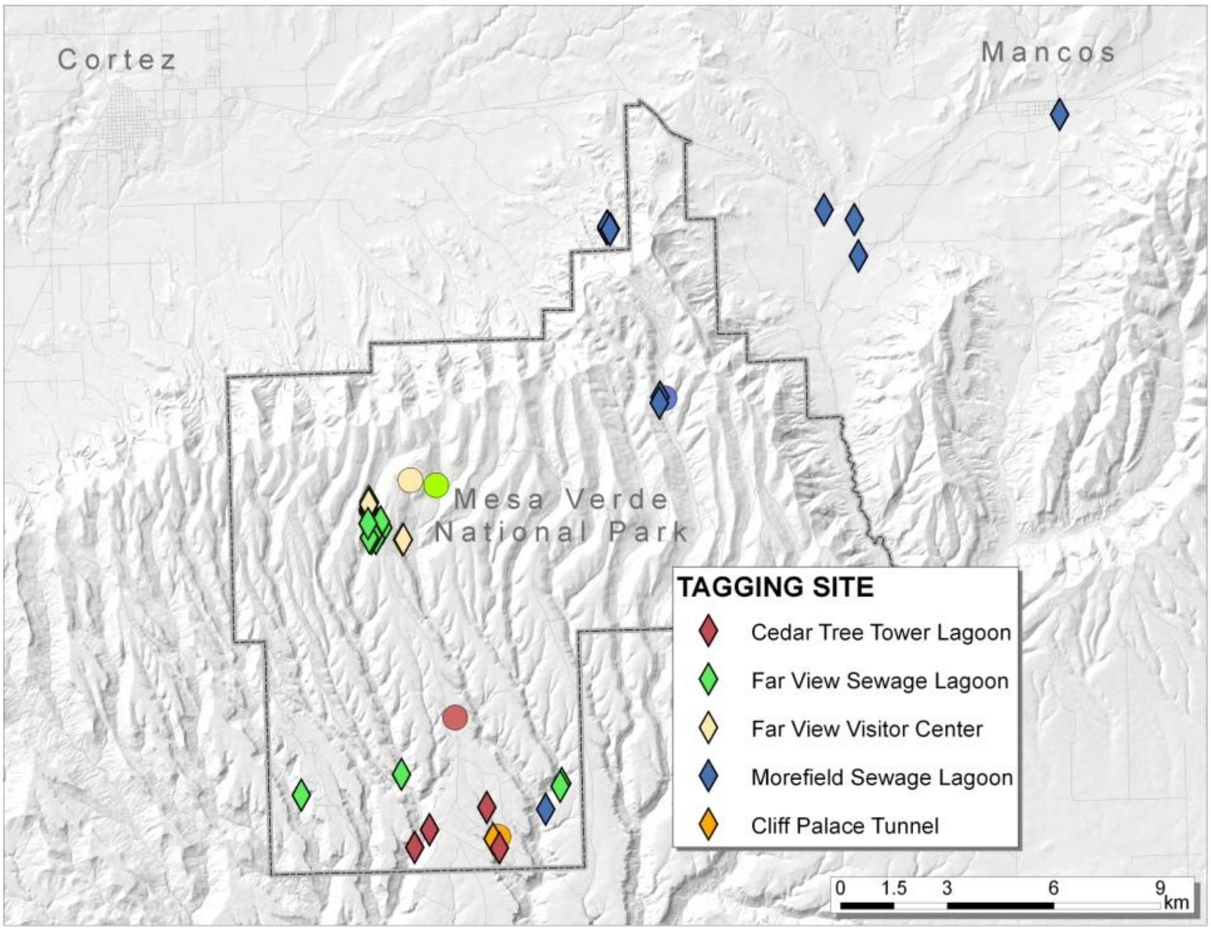
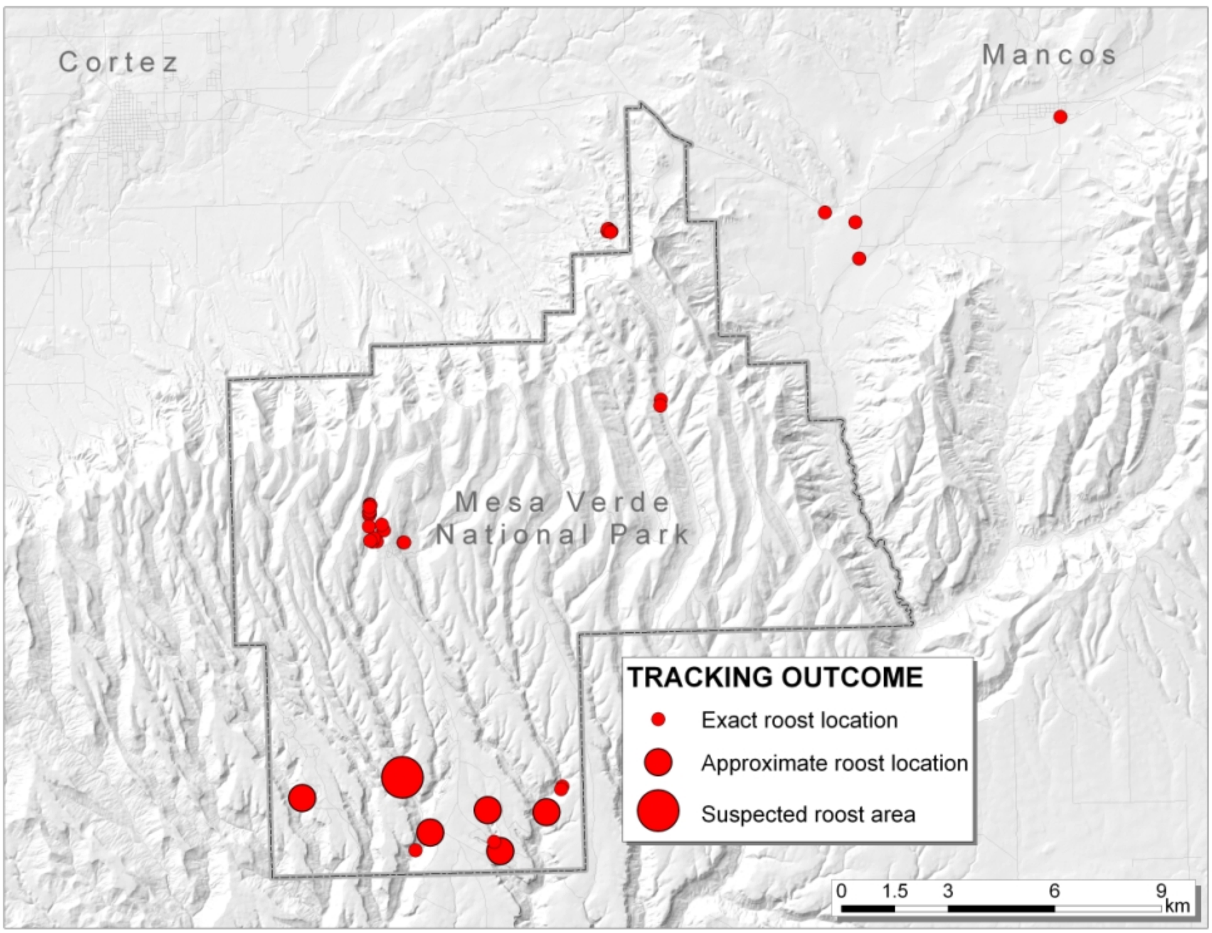


Figure IV.5. Map of Mesa Verde National Park and surrounding areas showing the precision of location for roosts discovered by radiotracking during the summer of 2006. Small circles indicate that the exact location of a roosting bat was established. Medium circles indicate that the signal of a bat was tracked to a specific site, but that the exact location of the bat at that site was not determined, usually because of inaccessibility (for example, the presence of cliffs). The large circle indicates that the signal of a tagged bat was triangulated to that area, but was not localized to within <500 m before the transmitter failed.



V. Echolocation Activity of Bats at Burned and Intact Piñon-Juniper Sites

By Laura E. Ellison

Introduction

Bat activity and habitat use in relation to forest type, structure, and management practices have been studied extensively in recent years (Humes and others, 1999; Patriquin and Barclay, 2003; Ford and others, 2006; Loeb and O'Keefe, 2006; Yates and Muzika, 2006). However, little is known about how forest fire affects habitat use and foraging activity of bats (Boyles and Aubrey, 2006; Fisher and Wilkinson, 2005). In a recent study of the roosting ecology of evening bats (*Nycticeius humeralis*) after prescribed burning of oak-hickory forests, it was found that fire might increase both the quantity and quality of roosting habitat for this species by creating an increase in the number of dead and dying trees (Boyles and Aubrey, 2006). We studied bat activity in Bandelier National Monument, N. Mex., and found that activity levels in burned ponderosa pine forests (1977 La Mesa fire) were similar to activity levels in mixed coniferous forests (Ellison and others, 2005). The lowest amount of activity was found in piñon-juniper habitats and was highest along riparian corridors. Bat activity and foraging in piñon-juniper forests immediately after a fire is expected to be variable depending on the bat species present and on how many trees are left standing. Species that most often forage in open habitats (aerial hawkers and larger-bodied, less maneuverable species) would potentially benefit from the effects of fire, whereas species that forage in more cluttered habitats (that is, gleaners and smaller-bodied *Myotis* bats) might not benefit.

Acoustic surveys are commonly used to index habitat use by bats across landscapes (for example, Furlonger and others, 1987; Thomas, 1988; Jung and others, 1999). However, these types of surveys do not provide a true estimate of abundance but only relative activity levels when applied to simultaneous comparisons of habitats (Hayes, 1997, 2000). Our main objective for the first summer of fieldwork was to compare indices of bat foraging activity between burned and intact piñon-juniper forests at Mesa Verde National Park. We hypothesized that bat activity would be higher in burned areas than within intact piñon-juniper forests, especially for bats that tend to forage in open habitats (that is, larger, less maneuverable species). A secondary objective was to collect representative bat calls from known species to aid in identification of calls collected passively. We considered this first summer as a pilot study to investigate if we could detect differences in foraging activity by bats between burned and intact piñon-juniper forests. Based on our results from this pilot study, we would make recommendations whether or not to continue a second summer of acoustic monitoring.

Methods

Call Library

We developed a call reference library by recording vocalizations from bats captured with mist-nets at three water sources within the park (the sewage lagoons at Far View and Morefield Canyon and the pump station at the park entrance) and one location in Mancos Valley (stock pond). Recordings were made using an Anabat II detector (Titley Electronics, Ballina, New South Wales, Australia) interfaced with an IBM-compatible laptop computer using a zero-crossings analysis interface module (ZCAIM) to produce instantaneous time-frequency displays. We released each bat in an open area near the capture site but far enough from the water source to minimize the potential for interference from other foraging bats. Three people participated in the recordings: one released the bat, the second spotlighted the bat as it flew upon release, and the third operated the bat detector.

Acoustic Monitoring

We randomly selected two sites in intact and two sites in burned piñon-juniper forest on Chapin Mesa using a geographic information system (GIS; see fig. V.1). We began by generating 200 random locations and constrained their distribution to areas on top of mesas and accessible by road, yet more than 250 m from the nearest road or building. We then used GIS to relate these locations to information on the distribution of burned and intact piñon-juniper forest on the park. Random locations were divided into two groups: those that fell within burned areas and those that fell within intact areas. After assigning a unique number to each location, we used a random number generator to select two locations in burned areas and two in intact areas. Locations within a treatment were at least 250 m apart. These locations were used for our bat detector sampling stations (hereafter stations; fig. V.1). In the field, we marked each station with fence posts of similar height (1.5 m). We passively monitored bat calls at each station using an Anabat II bat detector connected to a programmable zero-crossings analysis interface module (Anabat CF Storage ZCAIM). We placed the detectors and ZCAIMs in weatherproof steel boxes angled at 45^0 to a reflective polycarbonate plastic surface (O'Farrell, personal commun., 2007; see photo 1, appendix VI). Detectors were calibrated to minimize variation in zone of reception among units. Detector microphones were oriented in random cardinal directions, except in cases where random orientation caused microphones to be obstructed by a habitat feature, such as a tree branch.

We monitored activity levels of bats for 10 nights each in June, July, and August at the four stations on Chapin Mesa (fig. V.1). Dates of sampling were June 15–25, July 14–24, and August 14–24. We chose these dates based on moon phase; each sampling period began two nights after the last moon quarter and continued for 10 nights. We set detectors to begin collecting calls at sunset and to end data collection at sunrise. Because of equipment malfunctions, sampling took place across all four stations simultaneously for eight nights in June, seven nights in July, and eight nights in August. We viewed all Anabat files collected for purposes of species identification and quantifying bat passes, but we use data from only those nights when all stations were working properly to summarize and model activity levels between burned and intact sites.

We downloaded echolocation call data from detectors every other day and cleared the storage ZCAIMs for redeployment. We analyzed calls using Analook for Windows software 3.2o (http://users.lmi.net/corben/anabat.htm). Calls were identified to species based on qualitative and quantitative parameters from known call libraries (C. Corben and M. O'Farrell, O'Farrell Biological Consulting, unpub. data, 2007) and published accounts (O'Farrell and others, 1999; Everette and others, 2001; Ellison and others, 2005). Characteristics used as reference points were shape of the call, characteristic frequency, maximum and minimum frequency, bandwidth, and duration of individual call pulses. We combined counts of calls from silver-haired bats (*Lasionycteris noctivagans*) and big brown bats (*Eptesicus fuscus*) into one category because these species can exhibit overlapping call characteristics (Betts 1998). We also assigned calls not readily identified with species to one of three groupings: a low-frequency group (generally 20–30 kHz bats), a 40-kHz *Myotis* group, and a 50-kHz *Myotis* group. The low frequency group of bats consisted of the following four species: big brown bats, silver-haired bats, hoary bats (*Lasiurus cinereus*), and Brazilian free-tailed bats (*Tadarida brasiliensis*). The 40 kHz *Myotis* group consisted of the following four species: small-footed myotis (*Myotis ciliolabrum*), long-eared myotis (*M. evotis*), occult myotis (*M. occultus*), and long-legged myotis (*M. volans*). The 50 kHz Myotis group consisted of calls from either of the yuma myotis (*M. yumanensis*) and the California myotis (*M. californicus*). We assumed that calls collected in each of these species groups had an equal probability of detection.

We defined a "bat pass" as a continuous sequence of $\geq$2 call pulses produced by a single bat from the moment it was first detected until it traveled beyond the range of detection (Thomas, 1988). Detections of <2 call pulses and detections of no visible call structure were not used for species identification or statistical analyses. We assumed that the number of bat passes collected per station were independent events. In addition to quantifying number of bat passes by species, we quantified the number of foraging attempts or feeding buzzes by species. We calculated means, standard deviations, and 95 percent confidence intervals of bat passes by station, treatment, and month (all species of bats combined). For statistical modeling, we compared activity among stations and treatments using only the low-frequency group and the 40 kHz *Myotis* group because combining all species invalidates our assumption of equal detection probability. We used generalized linear models in the program R (R Development Core Team, 2006) to model bat passes among stations, treatments, date within a month, and month. Because count data are not distributed normally, we used the Poisson distribution to model the number of bat passes (Neter and others, 1996). We chose the most parsimonious model using Akaike's Information Criterion (AICc), a criterion for model selection based on information theory, which penalizes the model fit (maximum log-likelihood) by twice the number of parameters (Venables and Ripley, 1994).

Results

Call Library

We recorded the calls of eight species of bats during 49 hand releases (table V.1), and made additional recordings of free-flying Brazilian free-tailed bats and canyon bats (*Parastrellus hesperus*). The most frequently hand-released and recorded species were long-legged myotis, long-eared myotis, small-footed myotis, and silver-haired bats. The number of representative calls in the library was a reflection of mist-net captures; species more difficult to capture lacked good representation in the library. See appendix V for examples of time-frequency displays from known species. Not all of the hand-released calls that we collected accurately reflect the characteristics of the species. When bats are initially released after capture, echolocation calls are not typically of the search phase type. Hence, recording long sequences from individuals is more useful than recording short sequences, the latter of which are more frequent during hand releases.

Acoustic Monitoring

A total of 15,389 files were collected to storage ZCAIMs during June, July, and August from all stations combined (table V.1). Of these files, 12,888 were identified to species or species groups (83.7 percent) and the remaining numbers of files were considered unidentifiable or were not $\geq$2 pulses in duration (3,215). The total number of identified and unidentified bat passes does not equal or add up to the total number of files collected because many of the files contained passes by multiple species or individuals. Sixteen species were identified and the largest number of passes were attributed to Brazilian free-tailed bats (3,143 passes), followed by the big brown bat/silver-haired bat group (2,779 passes), canyon bats (291), and small-footed myotis (146). More low frequency bat passes were collected at burned locations than intact locations. Conversely, more passes of *Myotis* sp. were collected from intact locations than burned. Foraging attempts or feeding buzzes were low in both treatments indicating little use of the piñon-juniper as a food resource. All species captured using mist nets were detected at acoustic monitoring stations. Additionally, we collected calls from big free-tailed bats (*Nyctinomops macrotis*) with acoustic monitoring, yet never captured this species using mist nets.

There was generally more bat activity (total number of bat passes, all species) collected per night in burned locations than intact locations (table V.2, fig. V.2), but 95 percent confidence intervals often overlapped within and between treatments. Activity also varied by date and month. Similarly, there were more foraging attempts or feeding buzzes collected per night in burned locations (fig. V.3). Foraging activity in general was very low at all locations. Average activity during June at all stations and treatments was significantly higher than during July and August, as substantiated by non-overlapping 95 percent confidence intervals. However, activity among sites was more variable due to night-to-night differences and correspondingly large standard deviations (table V.2). More foraging attempts were recorded in June as well, but the average number of feeding calls detected did not differ significantly from July and August sampling periods. In June, activity at intact locations ranged from 11–265 passes per night and 25–1,062 passes in burned areas. In July, activity ranged from 10–37 passes at intact locations and 14–201 passes at burned locations. In August, activity ranged from 6–28 passes at intact locations and 7–126 in burned locations. Station C, which was located in burned piñon-juniper forest (fig. V.1), had consistently higher activity levels during all three months, which may be due to its close proximity to Soda Canyon.

The models selected with AICc that parsimoniously explained most of the variation in activity of low frequency and 40 kHz *Myotis* groups were those that included station (4 sites), date (within a month), and month (Passes~Station+Date+Month; table V.3). All other models were more than 1,307.3 ΔAICc values from the top model. Station location, month, and date explained more of the variability in activity levels than treatment (burned or intact) alone. We would need to increase the number of stations within burned and unburned sites in order to determine whether the differences in bat activity observed was due to a treatment effect (burned versus intact) and not due to temporal or site-specific differences. Using a balanced ANOVA (analysis of variance) power analysis, with an effect size of 1.25, P-value of 0.05, and power of 0.80, at least 10 replicate stations would have to be established in each treatment type.

Discussion

Our results indicate that habitat use and echolocation activity by bats in burned and intact piñon-juniper differs with more activity in burned locations, but we cannot quantitatively attribute the differences to the effects of fire alone. Variability in numbers of bat passes for both low frequency bats and species within the 40 kHz *Myotis* sp. group was best explained by temporal patterns and by station (point), but not by treatment (fire). The least supported model was one that included treatment (fire) only. Both bat activity and foraging attempts were highest at burned locations and during the month of June. However, foraging activity was very low in all four locations, indicating that piñon-juniper forests on Chapin Mesa may be used mostly by commuting rather than foraging bats. Although we did not simultaneously collect information on insects at the Anabat locations, the low number of feeding calls collected at the stations may directly correlate with low insect abundance. Bat activity and foraging was also highest at Station C in the burned habitat, which may be a result of its proximity to the rim of Soda Canyon. From radiotracking results in 2006 (see Cryan, section IV, this report), it appears bats are predominantly roosting in crevices in canyons, where activity levels might be much higher than those we observed. The large amount of bat activity at Station C may simply be the result of bats commuting from their roosts in Soda Canyon to water areas for drinking water and better sources of insects.

Previous studies on habitat use and foraging activity of forest bats have found that forest structure, not forest type, is the most important factor determining habitat use (Loeb and O'Keefe, 2006). In general, bats are found to use more open forest stands, such as recent clearcuts, than forests with greater structural clutter. Forest fires mimic clearcuts in that they reduce structural complexity and create more open spaces, which could be why we observed the highest levels of bat activity in burned areas on Chapin Mesa. Composition of bat species using an area will also be different depending on forest structure. Larger species with higher wing aspect ratios and wing loading tend to forage in open habitats, whereas smaller species with lower aspect ratios and wing loading tend to forage in more cluttered habitats (Fisher and Wilkinson, 2005). We found a similar pattern in that the stations in intact piñon-juniper forest collected more bat passes by *Myotis* sp. than the stations in burned locations during all three months of sampling. Conversely, the calls of low-frequency bats such as big brown bats, silver-haired bats, and Brazilian free-tailed bats dominated detector samples from burned locations. One caveat to this observed pattern is that detection probabilities differ among low-frequency bats and species of *Myotis*. Low-frequency bats presumably have a higher probability of being detected than *Myotis* sp. and the predominance of low-frequency bat passes in burned sites may have masked activity of less-detectible species of *Myotis*.

Recommendations

We make the following recommendations for further acoustic work during the summer of 2007:

1. Focus on collecting more hand-released calls with Anabat detectors to better develop a reference call library for the park. We only collected 49 hand-released recordings from eight species during the summer of 2006, some of which were not usable as reference calls due to interference from other bats, or because released bats did not echolocate in a useable way. We recommend collecting calls from more species and more individuals of each species. There are still nine species that occur on the park for which we do not have good reference calls.

2. We recommend not repeating the 10-night acoustic monitoring based on the modeling results from this first pilot season and by subsequent power analysis based on an ANOVA design for detecting a treatment effect. By using the means and standard deviations from this first summer, we were able to calculate an effect size and run a power analysis. We determined that it would take a minimum of 10 stations per treatment, or 20 stations total, to have 80 percent power to determine if a significant difference in bat activity exists between burned and intact piñon-juniper on Chapin Mesa.

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Table V.1. Number of bat passes (feeding buzzes in parentheses) per treatment (burned and intact) piñon-juniper identified to species and species groups at Mesa Verde National Park, Colo., from Anabat monitoring stations during the summer of 2006 (June, July, and August). Number of reference recordings made for the library are in parentheses directly following species name.

Species	**Total**	**June**		**July**		**August**	
		Burned	**Intact**	**Burned**	**Intact**	**Burned**	**Intact**
Myotis californicus (1)	43 (0)	12 (0)	9 (0)	2 (0)	11 (0)	2 (0)	7 (0)
M. ciliolabrum (8)	146 (0)	11 (0)	68 (0)	3 (0)	30 (0)	3 (0)	31 (0)
M. evotis (10)	99 (0)	16 (0)	27 (0)	3 (0)	37 (0)	4 (0)	12 (0)
M. occultus (6)	129 (0)	16 (0)	39 (0)	16 (0)	54 (0)	2 (0)	2 (0)
M. thysanodes (0)	18 (0)	1 (0)	4 (0)	1 (0)	7 (0)	3 (0)	2 (0)
M. volans (12)	98 (7)	9 (1)	72 (4)	1 (1)	6 (1)	0 (0)	11 (0)
M. yumanensis (2)	26 (0)	5 (0)	2 (0)	1 (0)	14 (0)	1 (0)	3 (0)
Lasiurus cinereus (0)	20 (0)	15 (0)	0 (0)	2 (0)	3 (0)	0 (0)	0 (0)
Lasionycteris noctivagans (8)	12 (0)	10 (0)	0 (0)	2 (0)	0 (0)	0 (0)	0 (0)
Parastrellus hesperus (0)	291 (158)	38 (2)	150 (139)	40 (2)	29 (10)	24 (4)	10 (1)
Eptesicus fuscus (2) + *L. noctivagans*	2,779 (245)	1,993 (179)	218 (27)	341 (15)	93 (12)	81 (9)	53 (3)
Euderma maculatum (0)	1 (0)	0 (0)	1 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Corynorhinus townsendii (0)	11 (0)	0 (0)	3 (0)	0 (0)	7 (0)	0 (0)	1 (0)
Antrozous pallidus (0)	64 (1)	29 (1)	10 (0)	4 (0)	16 (0)	2 (0)	3 (0)
Tadarida brasiliensis (0)	3,143 (124)	2,583 (101)	114 (9)	270 (4)	31 (0)	121 (8)	24 (2)
Nyctinomops macrotis (0)	698 (0)	358 (0)	31(0)	66 (0)	30 (0)	190 (0)	23 (0)
Low-frequency group	3,940 (45)	3,338 (37)	160 (1)	286 (4)	54 (0)	80 (2)	22 (0)
40-kHz *Myotis* group	1,275 (0)	93 (0)	1,018 (0)	34 (0)	84 (0)	11 (0)	35 (0)
50-kHz *Myotis* group	95 (0)	13 (0)	17 (0)	19 (0)	21 (0)	4 (0)	21 (0)
Total identified calls (49)	12,888 (580)	8,540 (321)	1,942 (180)	1,091 (26)	527 (23)	528 (23)	260 (6)
Total unidentifiable calls	3,215	2,439	214	320	90	118	34
Total files collected	15,389	10,289	2,117	1,418	626	647	292

Table V.2. Average number of bat passes (all species combined) and feeding buzzes per treatment (intact and burned) piñon-juniper at Mesa Verde National Park, Colo., from Anabat monitoring stations during the summer of 2006 (June, July, and August). [*n* = number of days per month]

Month (*n*)	Treatment	Site	Avg no. bat passes (± SD)	95% Confidence intervals	Avg no. of feeding buzzes (± SD)	95% Confidence intervals
June (8)[1]	Intact	A	52.7 (27.5)	33.7–71.8 *	3.0 (2.6)	1.2–4.8
		B	179.5 (91.9)	115.8–243.2	18.5 (24.1)	1.8–35.2
	Burned	C	639.1 (334.6)	407.3–870.9	25.6 (20.5)	11.4–39.8
		D	311.8 (164.7)	197.6–425.9	10.4 (4.8)	7.1–13.7
July (7)[2]	Intact	A	23.7 (8.6)	17.4–30.0	1.4 (1.4)	0.4–2.4
		B	21.3 (8.4)	15.0–27.5	0.4 (0.5)	0.02–0.8
	Burned	C	117.6 (44.3)	84.8–150.4*	2.6 (1.4)	1.6–3.6*
		D	25.9 (11.6)	17.3–34.4	0.6 (0.5)	0.2–1.0
August (8)[3]	Intact	A	13.9 (7.7)	5.6–19.2	0.4 (0.7)	0.2–0.7
		B	12.6 (5.7)	8.7–16.5	0.1 (0.4)	0.01–0.4
	Burned	C	45.3 (38.8)	18.3–72.2	1.8 (2.0)	0.4–3.2
		D	16.6 (10.5)	9.3–23.9	0.8 (1.2)	0.4–0.9

* Significantly different within a treatment at the P<0.05 level.

[1] Dates of sampling were June 16–18, 20–24, 2006.

[2] Dates of sampling were July 17–23, 2006.

[3] Dates of sampling were August 14, 17–23, 2006.

Table V.3. Table of model results for Anabat monitoring of burned and intact piñon-juniper at Mesa Verde National Park, Colo., during June, July, and August 2006. Numbers of low frequency bat passes and 40-kHz *Myotis* sp. passes were modeled by station (4), treatment (2), date, and month. The model incorporating station, treatment, date, and month was the best model chosen to explain bat activity. AICc values are reported, and ΔAICc values are in parentheses.

Model	**Low frequency passes**	**40-kHz *Myotis* passes**
Station + Date + Month	1,133.2 (0)	639.9 (0)
Treatment + Date + Month	2,789.4 (1,656.2)	1,947.2 (1,307.3)
Station + Month	3,881.9 (2,748.7)	1,058.1 (418.2)
Treatment + Month	5,538.1 (4,404.9)	2,356.3 (1,716.4)
Station	13,746.0 (12,612.8)	2,739.0 (2,099.1)
Treatment	15,402.0 (14,268.8)	4,046.2 (3,406.3)

Figure V.1. Map of Mesa Verde National Park showing areas burned by wildfire prior to 2006 (red area), areas of unburned piñon-juniper forest (green stippling), and location of bat detector stations (black triangles). See text for details of detector sites.

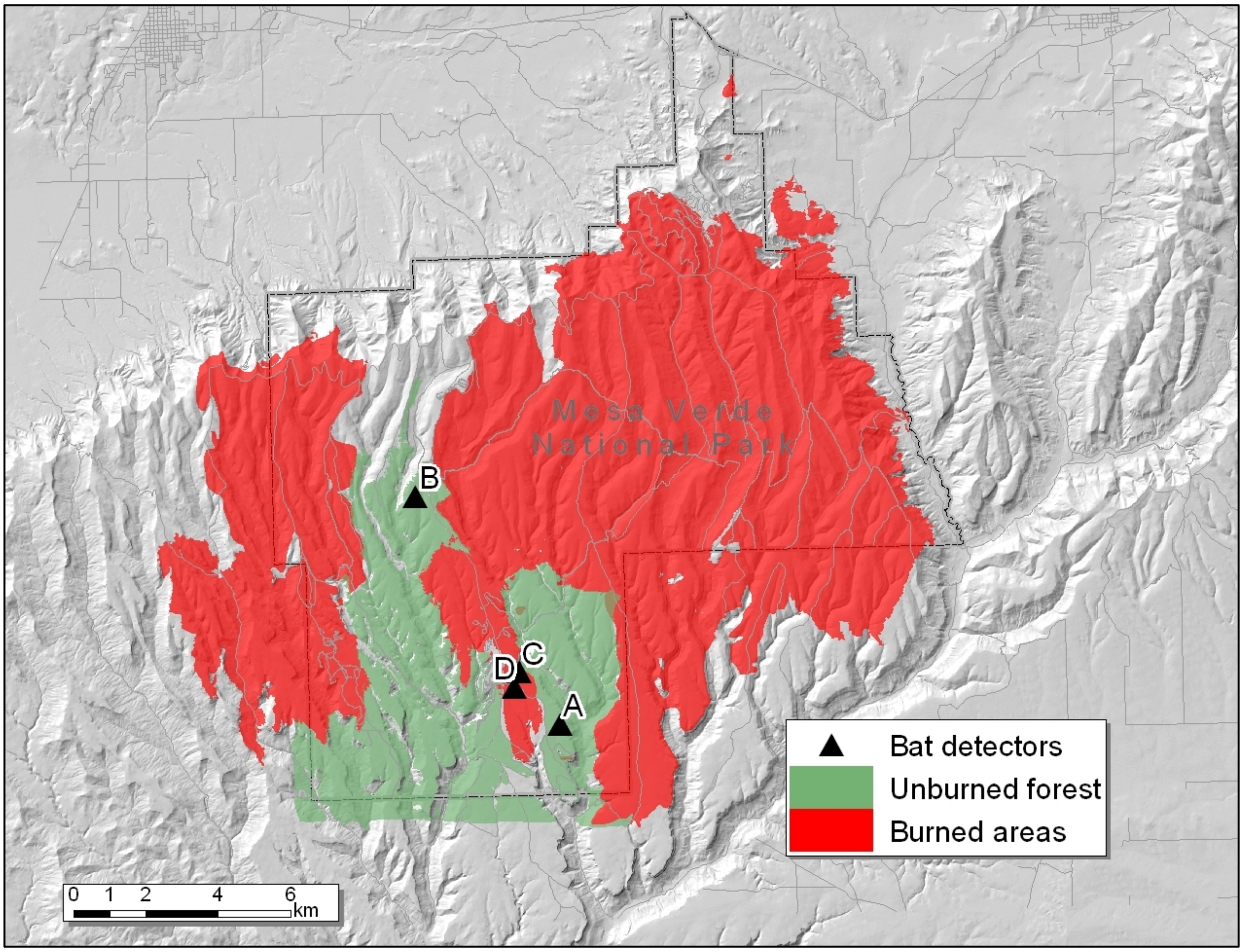


Figure V.2. Number of bat passes (all species combined) collected by date and location and Anabat monitoring stations in burned and intact piñon-juniper during summer 2006 at Mesa Verde National Park, Colo.

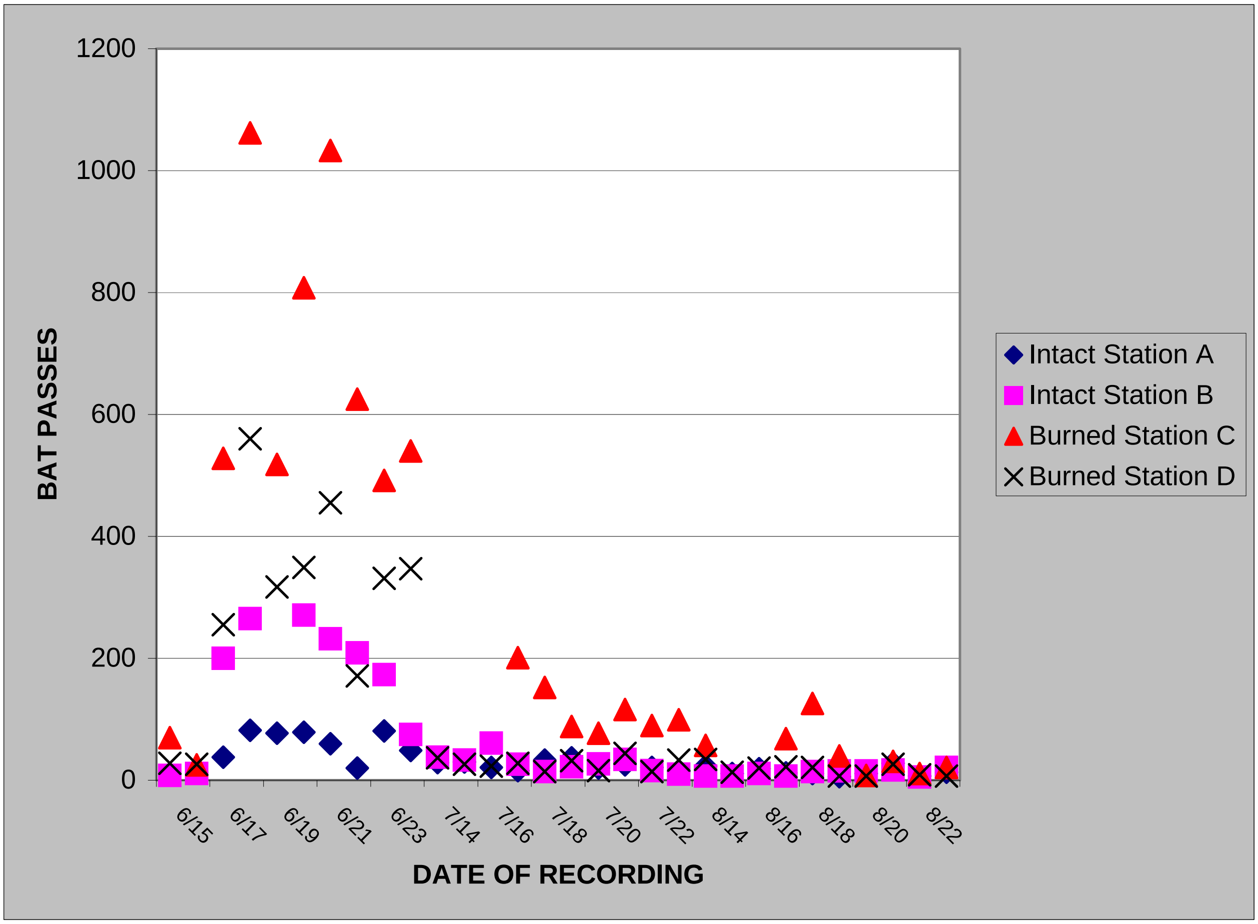
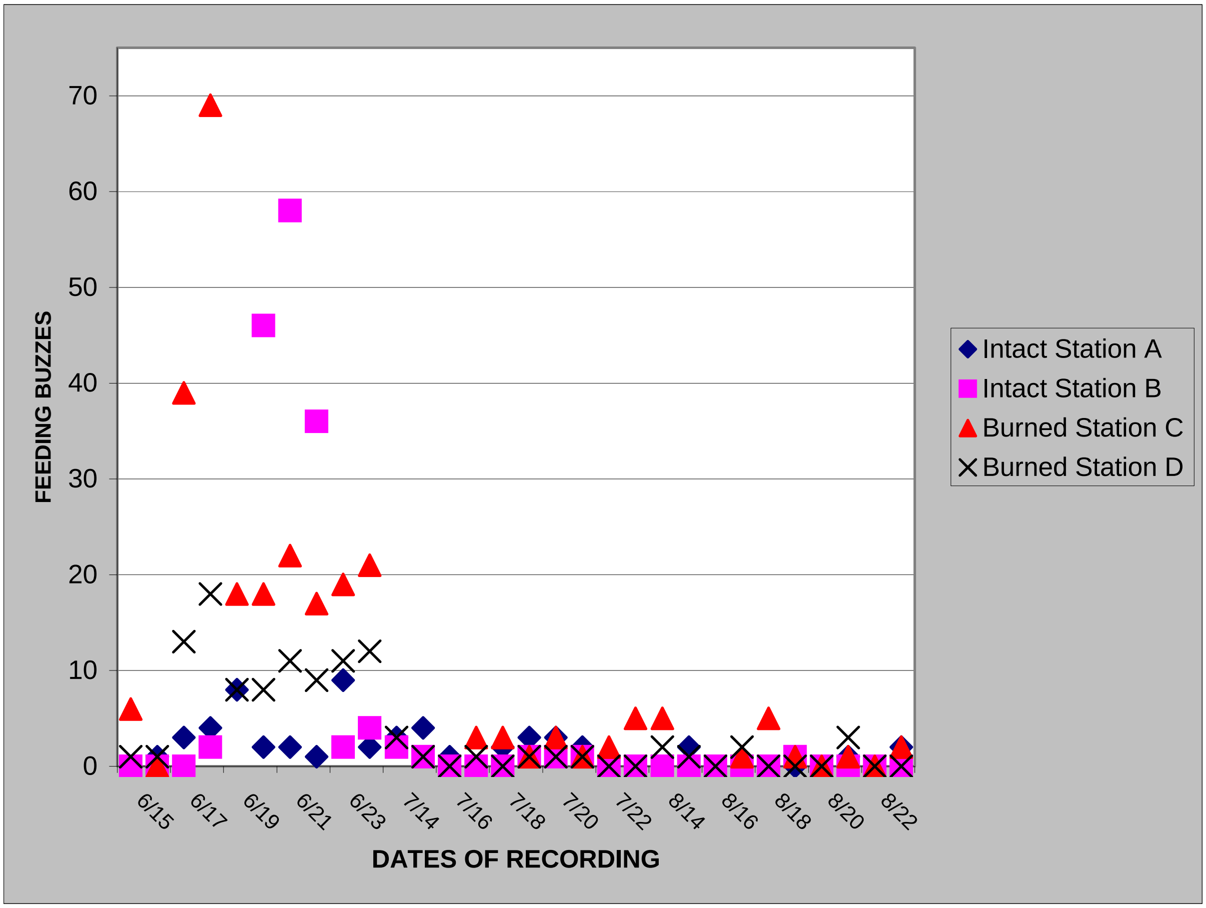


Figure V.3. Number of foraging attempts (feeding buzzes, all species combined) collected by date and location at Anabat monitoring stations in burned and intact piñon-juniper during the summer of 2006 at Mesa Verde National Park, Colo.



VI. Efficacy of Scent Detector Dogs in Assessing Bat Use of Piñon-Juniper Forests as Roost Sites

By Paul M. Cryan

Introduction

One of the greatest difficulties in assessing the use of forests by roosting bats is detecting their presence within trees. Bats often roost beneath loose bark and within cavities formed by primary excavators (for example, woodpeckers), as well as in crevices and natural cavities in the branches and trunks of trees. The chance of a tree having such features generally increases with age and bats are thought to favor older forests as roost sites because they offer more opportunities for roosting (Pierson, 1998). The mature piñon-juniper forests of Mesa Verde exemplify the abundance of potential roosting opportunities that come with forest age. Although it is sometimes feasible to locate bat roosts in trees by careful searching, this technique is not practical in forests such as those found at Mesa Verde. The sheer number of potential cavities and crevices where bats could roost in these forests, combined with the uncanny resemblance of bat guano and decomposing juniper needles, present a daunting challenge. Although radio tracking offers direct information on the roosting habits of bats, it is not practical for assessing use of specific forest stands because bats are wide-ranging and can only be captured efficiently at a limited number of sites, which may not be within the forest stand of interest. Better methods of detecting bats roosting in trees are needed. Trained scent dogs have proven effective at detecting other species of wildlife that are difficult to track or locate (Smith and others, 2001; Wasser and others, 2004; Smith and others, 2005) and offer promise toward finding bat roosts in trees. During the summer of 2006, we cooperated with a pilot study conducted by Dr. Alice Chung-MacCoubrey of the U.S. Forest Service to test the efficacy of using dogs to detect the use of trees by bats at Mesa Verde. Our objectives were (1) to determine whether scent dogs could detect bat roosts that were previously found through radio tracking, and (2) to determine if scent dogs could detect use of old-growth piñon-juniper forests by bats at Mesa Verde. Herein we provide a brief, preliminary report of our findings. The final results of this work will be reported, in the context of additional findings regarding scent detector dogs in other forest types, by Dr. Chung-MacCoubrey at a later date.

Methods

Two professionally trained scent detector dogs (Packleader Dog Training, Gig Harbor, Wash.) were brought to Mesa Verde between August 1 and 4, 2006. The dogs had been previously trained to detect small quantities of bat guano (as little as a teaspoon) from several different species and genera (for example, *Eptesicus*, *Myotis*, *Tadarida*). “Merlin” was an 8-year-old Labrador mix with 5 years of experience as a law enforcement narcotics dog. “Bruiser” was a 4-year-old Labrador with extensive experience tracking wildlife. The dogs were handled by Dr. Chung-MacCoubrey and Elizabeth Mering, who were both professionally trained and had several weeks of field experience with the dogs before arriving on the park. We conducted two types of experiments with the dogs at Mesa Verde. First, we ran the dogs through areas where we had previously detected bat roosts through radio tracking to see if they could find these specific roosts. Each dog was led separately through an area with known roosts and an observer (PMC) would note the reaction of the dog when it approached each roost site. Dog handlers had no prior information on the location of roosts. Next, we ran the dogs through old-growth piñon-juniper forests to determine if they could detect new bat roosts. During these experiments each dog was run separately along a predetermined transect and an observer noted when a dog “indicated” (a positive search reaction) on a tree. The position of each tree at which a dog indicated was recorded using a GPS (global positioning system). As with the known-roost experiments, we compared the actions of each dog after they had independently run each transect. On two occasions we ran a single dog along transects without duplicating the search with the other. Most work took place in the morning and evening when conditions were optimum for detecting scent.

Results

On the morning of August 1 we ran both dogs past the four tree roosts used by the female *M. evotis* on BLM land north of the park (fig. VI.1). In this trial, both dogs clearly indicated on one of the roost trees (a downed log). Though they showed an interest in the three other roosts, the dogs were more ambiguous about indicating them. To the best of our knowledge, the roost on which the dogs indicated had been used by a single bat 30 days earlier. Next we took the dogs into the Mancos Valley to see if they could detect roosts used by colonies of *M. occultus*. The roost at the Hogan Trading Post on Highway 160 offered little challenge and both dogs indicated at the guano on the sidewalk beneath the roosting bats. The roost in the Old Mancos Theater was more challenging because a smaller amount of guano was scattered in the soil and grass at the base of the west wall of the building. Guiding the dogs separately, we walked each around the block, starting on the east side of the buildings and circling the theater from the north before passing under the west wall. Bats are known to roost in the chimney beneath the metal flashing high (>8 m) on the roof of the west wall. Both dogs clearly indicated on areas at the base of the west wall directly below the bat roost. We examined the ground closely and found small accumulations of guano where the dogs had indicated. The third and final trial at a known roost was carried out on August 2. On that day we ran both dogs past a crevice in a large boulder in the East Fork of Navajo Canyon that was used by a female *M. evotis* 17 days earlier. One of the dogs (Merlin) clearly indicated on the crevice when he encountered it. The other (Bruiser) showed initial interest, moved away, and then indicated when directed to revisit the site. We suspect that Bruiser had initial difficulty with this roost because of its height above the ground (1.5 m high on the top of a boulder).

Results of our attempts to locate new roosts in old-growth piñon-juniper forests were more ambiguous. We ran both dogs through two mature forest stands, located in different areas. At two additional forest sites we ran only one of the two dogs, not duplicating the run with the other dog. On August 2 we led both dogs through an elliptical transect on Chapin Mesa (fig. VI.1). Both dogs indicated on two of the same large trees, but because of the resemblance between bat guano and decomposing juniper needles, we were unable to confirm that they were indicating on bats or bat guano. We found no evidence that either tree was used by large numbers of bats (for example, obvious accumulations of fresh guano at the base or sides). Merlin repeatedly indicated on several large trees at which Bruiser did not indicate. On August 3 we ran one of the dogs (Merlin) through a forest stand on top of Park Mesa (fig. VI.1). Merlin indicated on several large juniper and piñon trees, but we were again unable to find any guano among the decaying juniper needles accumulated in the crevices and cavities near where the dog indicated. On the evening of August 3 we ran one of the dogs (Bruiser) in the mature conifer forest along the trail down Spruce Canyon (fig. VI.1). No indications were made on any of the trees searched during this exercise. On August 4 we ran both dogs independently, with approximately 30 minutes elapsing between runs, through a forest stand on Moccasin Mesa (fig. VI.1) and had similar results as our trials of August 2 on Chapin Mesa. Again, both dogs indicated on a few large trees that showed no obvious visual signs of bats, and which we could not accurately assess because of the juniper needles. We also observed that Merlin was indicating on more large trees than Bruiser at Moccasin Mesa. We suspect that, in addition to bat guano, Merlin was also indicating on colonies of small ants in some of the trees, thus explaining his indications on trees that were not pointed out by Bruiser. In addition, both Bruiser and Merlin each indicated at one item that was not bat guano. Bruiser indicated on an owl pellet at the base of a large pine snag (it contained mostly rodent bones) and Merlin indicated on a small pile of insectivorous bird droppings (for example, from a swallow or swift).

Discussion

Although we did not unambiguously detect the presence of bats using ancient forests in this study, we are confident that dogs are an efficacious way of detecting large colonies of bats roosting in trees on the park. Our trials with the known roosts of both *M. evotis* and *M. occultus* were promising. The dogs had no difficulty detecting the roosts of large colonies of *M. occultus* and were able to detect a proportion of the temporary roosts used by individual *M. evotis.* The latter results are promising because those sites contained very little scent. They were known to have been used by just one or two bats at least two weeks prior to being detected. In searching all of the tree roosts of *M. evotis*, we were only able to find very small quantities of guano. Our results from the blind searches of forest stands were less satisfying because we did not gather any unambiguous evidence of the dogs detecting use of trees by bats. Both dogs indicated on several large trees with abundant crevices and cavities, but we were unable to tell whether there were small amounts of guano at these sites because of the decayed juniper needles. Our general impression is that the dogs were detecting small quantities of guano that had been left in or around trees by solitarily roosting bats. On two occasions we found individual guano pellets stuck to the bark of trees. The possibility that Merlin was indicating on trees with ant colonies attests to the sensory abilities of scent dogs. There are several potential reasons why Merlin indicated on ant colonies. First, ants were observed regularly feeding on guano samples set out during his training and early field trials (A. Chung MacCoubrey, oral commun., 2006). Thus, he may have learned to indicate on the scent of both the target substance and the insect that was often associated with it. Second, the exoskeletons of ants, which are made of a material called chitin, may smell similar to bat guano, which is comprised mostly of chitin from the exoskeletons of insect prey. Finally, it is possible that ant colonies using trees at Mesa Verde regularly forage on bat guano found in trees and on the forest floor and incorporate its scent. Despite Merlin's detection of ants, we are fairly confident that the dogs would have easily detected the presence of active bat colonies had any been using the trees we searched. However, our results do not provide conclusive evidence that bats do not form colonies in trees at Mesa Verde because the areas we surveyed were extremely limited (fig. VI.1). If bats are forming large colonies in trees on the park, they will likely be patchy in distribution and relatively rare in the landscape. Using trained dogs to search trees at Mesa Verde is likely an effective way to assess the use of forests by roosting bats on the park.

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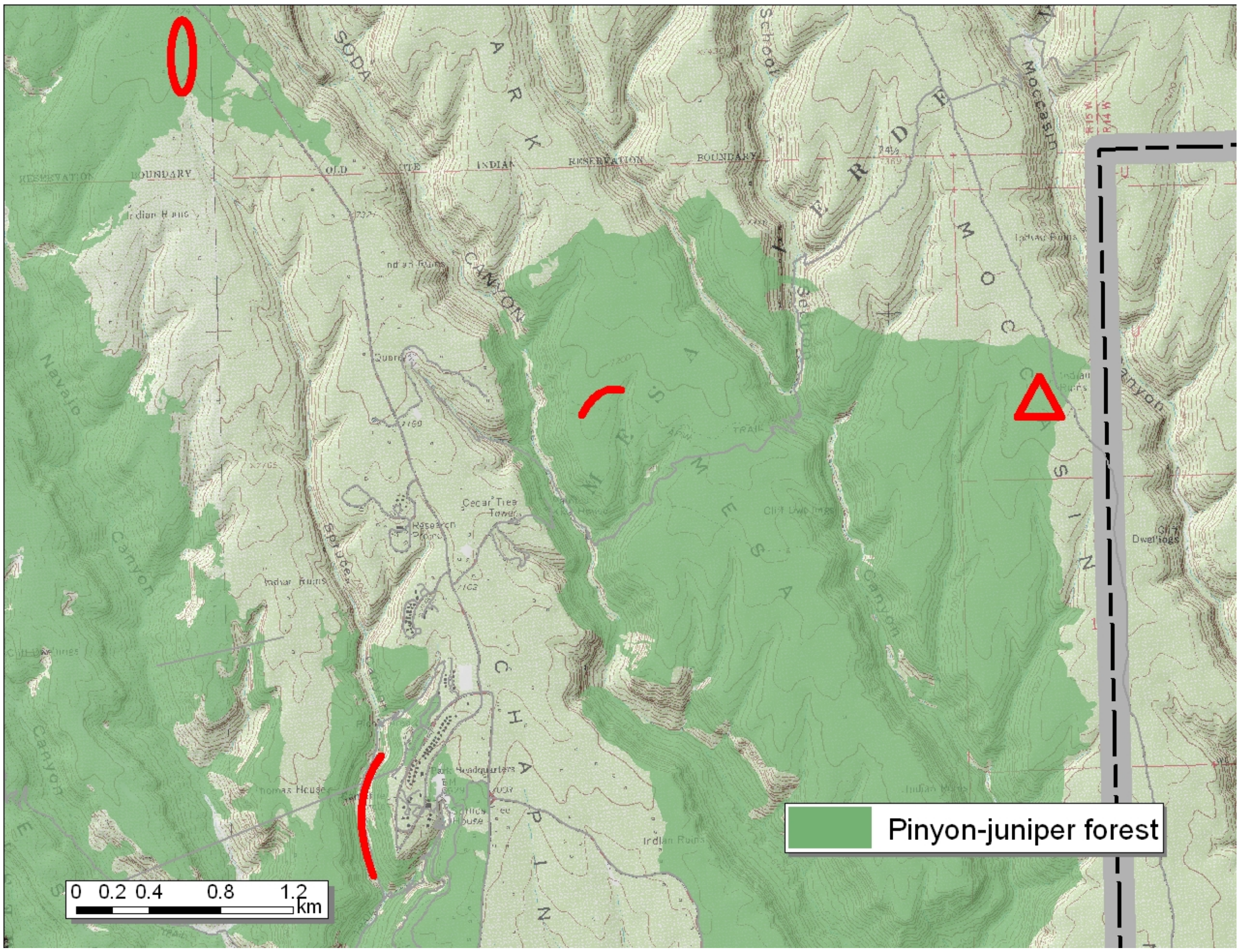
Figure VI.1. Map of the southern end of Mesa Verde National Park. The darker green shading represents areas of piñon-juniper forest considered for the study, and the red lines indicate the transects where the scent dogs were used to search trees for use by bats.



VII. Other Natural History Observations in Summer 2006

By Thomas J. O'Shea, Paul M. Cryan, Laura E. Ellison, Daniel J. Neubaum, E. Apple Snider, and Ernest W. Valdez

During the course of fieldwork we made a number of casual observations on wildlife at Mesa Verde. These observations are noted in table VII.1. In addition to these notable wildlife sightings, we frequently encountered horses and horse droppings at multiple locations throughout the park.

Table VII.1. Miscellaneous wildlife observations made at Mesa Verde in the course of bat-related fieldwork on bats. Initials correspond to author initials for Section VII of this report.

Species	Scientific Name	Date	Location	Initials
Rock Squirrel (one-eyed female)	*Spermophilus variegatus*	June–Aug	Navajo Loop, Morefield campground	TJO
Black bear	*Ursus americanus*	June 16	Park Rd. approx. 2.5 km N of Far View Visitor Center	EWV/ DJN
Mountain lion (scat)	*Felis concolor*	July 19	Navajo Canyon N of confluence with Wickiup Canyon	TJO
Long-tailed weasel	*Mustella frenata*	May 17	Natural resources office	DJN/ PMC
Long-tailed weasel	*Mustella frenata*	June 27	Morefield Canyon rd. approx. 0.7 km S of Morefield Village, pulling rabbit carcass off road	TJO
Long-tailed weasel	*Mustella frenata*	July 14	Campsite nearest employee housing at Morefield Village	PMC
Long-tailed weasel	*Mustella frenata*	July 18	Upper restrooms at Navajo Loop campsite Morefield	TJO
Coyote	*Canis latrans*	July 23	Far View sewage lagoons	DJN
Yellow-bellied marmot	*Marmota flaviventris*	May 24	Sewage lagoons at Morefield Canyon	PMC
Bobcat	*Lynx rufus*	July 16	Crossing road approx. 1.5 km N of Park Point turnoff	PMC
Striped skunk	*Mephitis mephitis*	July 28	Spruce Canyon near confluence with Navajo Canyon	PMC
Northern pygmy owl	*Glaucidium californicum*	July 19	Spruce Canyon near confluence with Navajo Canyon	DJN
Cooper's hawk (2)	*Accipiter cooperii*	July 19	Spruce Canyon	TJO
Cooper's hawk	*Accipiter cooperii*	Aug 16	East Fork, Navajo Canyon	TJO
Spotted sandpiper	*Actitis macularia*	May 19	Cedar Tree Tower sewage lagoon	PMC
Spotted owl	*Strix occidentalis*	July 27	Bottom of Spruce Canyon near Thomas House	PMC
Spotted owl	*Strix occidentalis*	June 28	Spruce Canyon	TJO
Golden eagle	*Aquila chrysaetos*	June 30	Above East Fork Navajo Canyon	PMC
Golden eagle (2)	*Aquila chrysaetos*	Apr 20	Above White's Mesa	TJO
Golden eagle (3)	*Aquila chrysaetos*	July 20	Rocks above Morefield sewage lagoon at sunset	TJO
Common night hawk	*Chordeiles minor*	July 14	Netted at sewage lagoons at Far View	PMC
Prairie rattlesnake	*Crotalus viridis*	July 2	Trail into East Fork Navajo Canyon	PMC
Prairie rattlesnake	*Crotalus viridis*	June 8	South Slope of Lone Cone (near Morefield Campground)	EAS
Prairie rattlesnake	*Crotalus viridis*	July 5	West side of East Fork Navajo Canyon	EAS
Tiger salamanders (20+)	*Ambystoma tigrinum*	Aug 1	Morefield sewage lagoon	EAS

VIII. Acknowledgments

George San Miguel and Marilyn Colyer facilitated many of our activities and provided logistical support. Marilyn Colyer provided loan of Anabat II echolocation detectors. Patricia Stevens and Jerry Godbey at the U.S. Geological Survey's Fort Collins Science Center provided administrative support. Mike Bogan of the Center's Albuquerque field station provided advice, background on the 1989–1994 surveys, and provided the Museum of Southwestern Biology records for bats at Mesa Verde. Michael J. O'Farrell graciously aided in identifying questionable Anabat call recordings and provided assistance with Analook for Windows. Thanks to Apple Snider, Jason Much, Jennifer Lamb, and Kim Briones for much help in sampling and tracking bats and for good company in the field. Dan and Melissa Neubaum lent their expertise to the radiotracking and bat surveys.

Appendices

Appendix II. Photos of bat work at Mesa Verde National Park during 2006.

Photo 1. We monitored bat echolocation calls in several areas of the park using remote bat detectors. Anabat ultrasonic bat detectors were fitted inside metal cases and affixed to steel posts. Detector microphones were oriented downward to avoid damage from rain. Bat calls were deflected into the microphone from an acrylic glass plate mounted on a steel bracket near the bottom of the case. These detectors were programmed to automatically turn on and off near sunset and sunrise.

Photo 2. We captured bats in mist nets set near water sources (mostly sewage lagoons). In this photo, Tom O'Shea and Ernie Valdez are setting up a "stacked net" which we used to catch bats flying higher than 2–3 m.

Photo 3. Bats were captured at night as they drank and foraged over water sources on the park. This photo shows a male silver-haired bat (*Lasionycteris noctivagans*) entangled in a mist net.

Photo 4. We radiotracked bats to their daytime roosts. In this photo, graduate student E. Apple Snider of Colorado State University pinpoints the location of a female spotted bat roosting in a cliff in Rock Canyon.

Photo 5a and 5b. A female long-eared myotis (*Myotis evotis*) with a miniature radio transmitter glued to her back, before and after release. Transmitters typically fall off of the bat after about two weeks.

Photo 6. One of the female long-eared myotis (*Myotis evotis*) that we tracked during June 2006 was found roosting in trees north of the park. During one of the days it was followed, this bat roosted in a log at the base of the tree in the foreground of the photo.

Photo 7. Most of the bats that we radiotracked were found roosting in rock crevices. This photo shows a typical crevice in a boulder used by a female long-eared myotis. The bat was found in the crevice seen at the top of the boulder.

Photo 8. All three of the spotted bats (*Euderma maculatum*) that we followed were found roosting in crevices in the faces of high cliffs. This photo is of the Echo Cliff area, taken from the Navajo Canyon Overlook. During 2006, we found a maternity colony of spotted bats roosting in the area of the cliff circled in yellow.

Photo 9. We conducted a pilot experiment to test the feasibility of using professionally trained scent dogs to detect bat roosts in trees at Mesa Verde. In this photo, Dr. Alice Chung-MacCoubrey encourages a scent dog to investigate crevices in the trunk of a juniper tree.

Photo 10. We tested the ability of scent dogs to detect the known roosts of bats that we had previously found through radiotracking. In this photo, one of the dogs investigates a bat roost on top of a boulder. We made sure that bats were no longer using these roosts before running the test.

Appendix III.1. Summary of capture records for bats at Mesa Verde National Park, 2006. Additional data available for most specimens include time of capture, forearm length, body mass, and comments. All bats were released on site the night of capture except for a limited number of voucher specimens. The full database will be provided to Mesa Verde National Park with the final report. Abbreviations: M = male, F = female, A = adult, J = volant juvenile, NV = not visibly reproductive, NR = nonreproductive, S.L. = sewage lagoon, LACT = lactating, SCROT = scrotal, PREG = pregnant, NS = non–scrotal, PL = post-lactating, O = not determined, U = unknown.

SPECIES	SEX	AGE	REPRO	SITE	DATE
Antrozous pallidus	M	A	NV	Cedar Tree Tower S.L.	June 20
Corynorhinus townsendii	F	A	LACT	Cedar Tree Tower S.L.	July 7
Corynorhinus townsendii	F	A	NV	Cedar Tree Tower S.L.	June 14
Corynorhinus townsendii	F	A	NV	Cedar Tree Tower S.L.	June 20
Corynorhinus townsendii	M	A	NR	Cliff Palace Tunnel	July 12
Corynorhinus townsendii	F	A	NV	Far View S.L.	May 21
Corynorhinus townsendii	M	A	NV	Far View S.L.	June 23
Eptesicus fuscus	F	A	--	Cedar Tree Tower S.L.	July 16
Eptesicus fuscus	F	A	--	Cedar Tree Tower S.L.	July 16
Eptesicus fuscus	M	A	NR	Cedar Tree Tower S.L.	July 2
Eptesicus fuscus	M	A	NR	Cedar Tree Tower S.L.	July 2
Eptesicus fuscus	M	A	NR	Cedar Tree Tower S.L.	July 7
Eptesicus fuscus	M	A	NR	Cedar Tree Tower S.L.	July 26
Eptesicus fuscus	M	A	NR	Cedar Tree Tower S.L.	July 26
Eptesicus fuscus	M	A	NS	Cedar Tree Tower S.L.	Aug 2
Eptesicus fuscus	M	A	NS	Cedar Tree Tower S.L.	Aug 16
Eptesicus fuscus	M	A	NS	Cedar Tree Tower S.L.	July 26
Eptesicus fuscus	M	A	NS	Cedar Tree Tower S.L.	July 26
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 14
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 14
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 14
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20

Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 20
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	June 27
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	May 19
Eptesicus fuscus	M	A	NV	Cedar Tree Tower S.L.	May 19
Eptesicus fuscus	M	A	SCROT	Cedar Tree Tower S.L.	July 16
Eptesicus fuscus	M	A	SCROT	Cedar Tree Tower S.L.	July 16
Eptesicus fuscus	M	A	SCROT	Cedar Tree Tower S.L.	Aug 16
Eptesicus fuscus	M	A	SCROT	Cedar Tree Tower S.L.	July 11
Eptesicus fuscus	M	A	SCROT	Cedar Tree Tower S.L.	July 26
Eptesicus fuscus	F	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	F	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	NR	Far View S.L.	July 19
Eptesicus fuscus	M	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	NR	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	NV	Far View S.L.	May 18
Eptesicus fuscus	M	A	NV	Far View S.L.	May 18
Eptesicus fuscus	M	A	NV	Far View S.L.	May 18
Eptesicus fuscus	M	A	NV	Far View S.L.	May 18

Eptesicus fuscus	M	A	NV	Far View S.L.	May 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 18
Eptesicus fuscus	M	A	NV	Far View S.L.	June 23
Eptesicus fuscus	M	A	NV	Far View S.L.	June 23
Eptesicus fuscus	M	A	NV	Far View S.L.	June 23
Eptesicus fuscus	M	A	NV	Far View S.L.	June 25
Eptesicus fuscus	M	A	NV	Far View S.L.	June 25
Eptesicus fuscus	M	A	NV	Far View S.L.	June 25
Eptesicus fuscus	M	A	NV	Far View S.L.	June 26
Eptesicus fuscus	M	A	NV	Far View S.L.	June 26
Eptesicus fuscus	M	A	NV	Far View S.L.	May 21
Eptesicus fuscus	M	A	NV	Far View S.L.	May 21
Eptesicus fuscus	M	A	SCROT	Far View S.L.	July 14
Eptesicus fuscus	M	A	SCROT	Far View S.L.	July 14
Eptesicus fuscus	M	A	SCROT	Far View S.L.	July 14
Eptesicus fuscus	M	A	SCROT	Far View S.L.	Aug 21
Eptesicus fuscus	M	A	SCROT	Far View S.L.	Aug 14
Eptesicus fuscus	M	A	SCROT	Far View S.L.	Aug 14
Eptesicus fuscus	M	A	SCROT	Far View S.L.	Aug 14
Eptesicus fuscus	M	A	NR	Mancos River	July 22
Eptesicus fuscus	M	A	NR	Mancos River	July 22
Eptesicus fuscus	M	A	NR	Mancos River	July 22
Eptesicus fuscus	M	A	SCROT	Mancos River	July 22
Eptesicus fuscus	F	A	NR	Morefield S.L.	Aug 23
Eptesicus fuscus	F	A	PREG	Morefield S.L.	July 15
Eptesicus fuscus	M	A	NR	Morefield S.L.	Aug 23
Eptesicus fuscus	M	A	NV	Wetherill S.L.	June 22
Eptesicus fuscus	M	A	NV	Wetherill S.L.	June 22

SPECIES	SEX	AGE	REPRO	SITE	DATE
Eptesicus fuscus	M	A	NV	Wetherill S.L.	June 22
Euderma maculatum	F	A	PREG	Cedar Tree Tower S.L.	June 27
Euderma maculatum	F	A	LACT	Far View S.L.	June 30
Euderma maculatum	F	A	LACT	Morefield S.L.	July 20
Euderma maculatum	M	A	SCROT	Morefield S.L.	July 31
Lasiurus cinereus	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasiurus cinereus	M	A	NR	Cedar Tree Tower S.L.	Aug 7
Lasiurus cinereus	M	A	NR	Cedar Tree Tower S.L.	July 11
Lasiurus cinereus	M	A	NR	Cedar Tree Tower S.L.	July 26
Lasiurus cinereus	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasiurus cinereus	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasiurus cinereus	M	A	NV	Far View S.L.	June 26
Lasiurus cinereus	M	A	NR	Morefield S.L.	Aug 23
Lasiurus cinereus	M	A	NR	Morefield S.L.	Aug 23
Lasiurus cinereus	M	A	NS	Morefield S.L.	July 31
Lasiurus cinereus	M	A	NV	Morefield S.L.	May 24
Lasiurus cinereus	M	A	NV	Wetherill S.L.	June 22
Lasionycteris noctivagans	F	A	NV	Cedar Tree Tower S.L.	May 19
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 2
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 7
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 10
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 16
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 11
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 11
Lasionycteris noctivagans	M	A	NR	Cedar Tree Tower S.L.	July 11
Lasionycteris noctivagans	M	A	NS	Cedar Tree Tower S.L.	Aug 15
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20

SPECIES	SEX	AGE	REPRO	SITE	DATE
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 20
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	June 27
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	May 19
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	May 19
Lasionycteris noctivagans	M	A	NV	Cedar Tree Tower S.L.	May 19
Lasionycteris noctivagans	M	A	SCROT	Cedar Tree Tower S.L.	July 11
Lasionycteris noctivagans	M	A	SCROT	Cedar Tree Tower S.L.	July 11
Lasionycteris noctivagans	F	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	F	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NR	Far View S.L.	July 6
Lasionycteris noctivagans	M	A	NR	Far View S.L.	July 19
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 30
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 30
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 5

Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 15
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 18
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 23
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 25
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 25
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 26
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 26
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 26
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 26
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 26
Lasionycteris noctivagans	M	A	NV	Far View S.L.	June 30
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21

Lasionycteris noctivagans	M	A	NV	Far View S.L.	May 21
Lasionycteris noctivagans	M	A	SCROT	Far View S.L.	July 14
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Lasionycteris noctivagans	M	A	SCROT	Far View S.L.	July 17
Lasionycteris noctivagans	M	A	--	Far View S.L.	June 30
Lasionycteris noctivagans	M	A	--	Far View S.L.	June 30
Lasionycteris noctivagans	M	A	--	Far View S.L.	June 30
Lasionycteris noctivagans	M	A	--	Far View S.L.	June 30
Lasionycteris noctivagans	M	A	--	Far View S.L.	June 30
Lasionycteris noctivagans	F	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	F	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 5
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 15
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 15
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 15
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	Aug 23
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 20
Lasionycteris noctivagans	M	A	NR	Morefield S.L.	July 20
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 31
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 31
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 16
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 19
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 19
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 19
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 19
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 19
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24

Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	June 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 17
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 24
Lasionycteris noctivagans	M	A	NV	Morefield S.L.	May 24
Lasionycteris noctivagans	M	A	SCROT	Morefield S.L.	Aug 20
Lasionycteris noctivagans	M	A	SCROT	Morefield S.L.	Aug 23
Lasionycteris noctivagans	M	A	--	Morefield S.L.	June 7
Lasionycteris noctivagans	M	A	NV	Wetherill S.L.	June 22
Myotis californicus	F	A	LACT	Cedar Tree Tower S.L.	July 16
Myotis californicus	F	A	LACT	Cedar Tree Tower S.L.	July 11
Myotis californicus	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis californicus	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis californicus	F	A	NR	Cedar Tree Tower S.L.	Aug 22
Myotis californicus	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis californicus	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis californicus	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis californicus	F	A	NV	Cedar Tree Tower S.L.	June 27
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	July 7
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	July 7

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	Aug 22
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	Aug 22
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	Aug 22
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	July 11
Myotis californicus	M	A	NR	Cedar Tree Tower S.L.	July 26
Myotis californicus	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis californicus	F	A	NR	Cliff Palace Tunnel	July 12
Myotis californicus	M	A	NR	Cliff Palace Tunnel	July 12
Myotis californicus	F	A	NR	Far View S.L.	Aug 8
Myotis californicus	M	A	NV	Far View S.L.	June 23
Myotis californicus	F	A	PREG	Morefield S.L.	June 24
Myotis californicus	F	A	PREG	Wetherill S.L.	June 22
Myotis californicus	F	A	PREG	Wetherill S.L.	June 22
Myotis californicus	M	A	NV	Wetherill S.L.	June 22
Myotis ciliolabrum	F	A	LACT	Cedar Tree Tower S.L.	July 16
Myotis ciliolabrum	F	A	LACT	Cedar Tree Tower S.L.	July 18
Myotis ciliolabrum	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis ciliolabrum	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis ciliolabrum	F	A	NR	Cedar Tree Tower S.L.	Aug 22
Myotis ciliolabrum	F	A	NR	Cedar Tree Tower S.L.	July 11
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	May 29
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	F	A	NV	Cedar Tree Tower S.L.	June 20

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis ciliolabrum	F	A	PL	Cedar Tree Tower S.L.	July 11
Myotis ciliolabrum	F	A	PL	Cedar Tree Tower S.L.	July 18
Myotis ciliolabrum	M	A	0	Cedar Tree Tower S.L.	July 26
Myotis ciliolabrum	M	A	NR	Cedar Tree Tower S.L.	July 16
Myotis ciliolabrum	M	A	NR	Cedar Tree Tower S.L.	July 11
Myotis ciliolabrum	M	A	NS	Cedar Tree Tower S.L.	July 26
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	May 29
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 14
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 14
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 14
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 27
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	June 27
Myotis ciliolabrum	M	A	NV	Cedar Tree Tower S.L.	May 19
Myotis ciliolabrum	M	A	SCROT	Cedar Tree Tower S.L.	July 26
Myotis ciliolabrum	F	A	NV	Far View S.L.	May 30

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis ciliolabrum	M	A	NR	Far View S.L.	July 14
Myotis ciliolabrum	M	A	NR	Far View S.L.	July 14
Myotis ciliolabrum	M	A	NR	Far View S.L.	July 14
Myotis ciliolabrum	M	A	NR	Far View S.L.	July 14
Myotis ciliolabrum	M	A	NV	Far View S.L.	May 18
Myotis ciliolabrum	M	A	NV	Far View S.L.	June 18
Myotis ciliolabrum	M	A	NV	Far View S.L.	June 23
Myotis ciliolabrum	M	A	NV	Far View S.L.	June 23
Myotis ciliolabrum	F	A	NV	Morefield S.L.	June 19
Myotis ciliolabrum	F	A	NV	Morefield S.L.	June 19
Myotis ciliolabrum	F	A	NV	Morefield S.L.	June 19
Myotis ciliolabrum	F	A	NV	Morefield S.L.	May 17
Myotis ciliolabrum	F	A	NV	Morefield S.L.	May 17
Myotis ciliolabrum	F	A	NV	Morefield S.L.	May 17
Myotis ciliolabrum	F	A	PREG	Morefield S.L.	June 24
Myotis ciliolabrum	M	A	NR	Morefield S.L.	July 20
Myotis ciliolabrum	M	A	NV	Morefield S.L.	May 31
Myotis ciliolabrum	M	A	NV	Morefield S.L.	May 31
Myotis ciliolabrum	M	A	NV	Morefield S.L.	June 19
Myotis ciliolabrum	M	A	NV	Morefield S.L.	June 19
Myotis ciliolabrum	M	A	NV	Morefield S.L.	May 17
Myotis ciliolabrum	M	A	NV	Morefield S.L.	May 17
Myotis ciliolabrum	M	A	NV	Pump Station at entrance	May 20
Myotis evotis	F	A	LACT	Cedar Tree Tower S.L.	July 16
Myotis evotis	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis evotis	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis evotis	F	A	NR	Cedar Tree Tower S.L.	July 16
Myotis evotis	F	A	NR	Cedar Tree Tower S.L.	July 16
Myotis evotis	F	A	NR	Cedar Tree Tower S.L.	July 11
Myotis evotis	F	A	NR	Cedar Tree Tower S.L.	July 26
Myotis evotis	F	A	NR	Cedar Tree Tower S.L.	July 26
Myotis evotis	F	A	NV	Cedar Tree Tower S.L.	May 29

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis evotis	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis evotis	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis evotis	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis evotis	F	A	PL	Cedar Tree Tower S.L.	July 26
Myotis evotis	M	A	NV	Cedar Tree Tower S.L.	June 14
Myotis evotis	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis evotis	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis evotis	--	--	--	Cedar Tree Tower S.L.	July 11
Myotis evotis	F	A	NR	Cliff Palace Tunnel	July 12
Myotis evotis	F	A	NR	Cliff Palace Tunnel	July 12
Myotis evotis	M	A	NR	Cliff Palace Tunnel	July 12
Myotis evotis	M	A	NR	Cliff Palace Tunnel	July 12
Myotis evotis	M	A	NR	Cliff Palace Tunnel	July 12
Myotis evotis	F	A	LACT	Far View S.L.	July 14
Myotis evotis	F	A	LACT	Far View S.L.	July 14
Myotis evotis	F	A	NR	Far View S.L.	July 14
Myotis evotis	F	A	NR	Far View S.L.	July 14
Myotis evotis	F	A	NV	Far View S.L.	May 18
Myotis evotis	F	A	NV	Far View S.L.	May 18
Myotis evotis	F	A	NV	Far View S.L.	May 30
Myotis evotis	F	A	NV	Far View S.L.	June 5
Myotis evotis	F	A	NV	Far View S.L.	June 5
Myotis evotis	F	A	NV	Far View S.L.	June 5
Myotis evotis	F	A	NV	Far View S.L.	June 18
Myotis evotis	F	A	NV	Far View S.L.	June 18
Myotis evotis	F	A	NV	Far View S.L.	June 18
Myotis evotis	F	A	NV	Far View S.L.	June 18
Myotis evotis	F	A	PL	Far View S.L.	July 14
Myotis evotis	F	A	PREG	Far View S.L.	June 30
Myotis evotis	M	A	NR	Far View S.L.	July 6
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 14

Myotis evotis	M	A	NR	Far View S.L.	July 14
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 14
Myotis evotis	M	A	NR	Far View S.L.	July 19
Myotis evotis	M	A	NS	Far View S.L.	Aug 8
Myotis evotis	M	A	NS	Far View S.L.	Aug 14
Myotis evotis	M	A	NS	Far View S.L.	Aug 14
Myotis evotis	M	A	NV	Far View S.L.	May 18
Myotis evotis	M	A	NV	Far View S.L.	May 30
Myotis evotis	M	A	NV	Far View S.L.	May 30
Myotis evotis	M	A	NV	Far View S.L.	May 30
Myotis evotis	M	A	NV	Far View S.L.	May 30
Myotis evotis	M	A	NV	Far View S.L.	June 5
Myotis evotis	M	A	NV	Far View S.L.	June 5
Myotis evotis	M	A	NV	Far View S.L.	June 15
Myotis evotis	M	A	NV	Far View S.L.	June 18
Myotis evotis	M	A	NV	Far View S.L.	June 18
Myotis evotis	M	A	NV	Far View S.L.	June 18
Myotis evotis	M	A	NV	Far View S.L.	June 18
Myotis evotis	M	A	NV	Far View S.L.	June 18
Myotis evotis	M	A	NV	Far View S.L.	June 23
Myotis evotis	M	A	NV	Far View S.L.	June 26
Myotis evotis	M	A	NV	Far View S.L.	June 26
Myotis evotis	M	A	NV	Far View S.L.	May 21
Myotis evotis	M	A	SCROT	Far View S.L.	Aug 1
Myotis evotis	F	A	LACT	Far View Visitor Center	June 30
Myotis evotis	F	A	LACT	Mancos River	July 22
Myotis evotis	F	A	NR	Mancos River	July 22
Myotis evotis	F	A	NR	Morefield S.L.	Aug 9
Myotis evotis	F	A	NR	Morefield S.L.	Aug 20
Myotis evotis	F	A	NV	Morefield S.L.	May 31

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis evotis	F	A	NV	Morefield S.L.	May 31
Myotis evotis	F	A	NV	Morefield S.L.	May 31
Myotis evotis	F	A	NV	Morefield S.L.	June 16
Myotis evotis	F	A	NV	Morefield S.L.	June 16
Myotis evotis	F	A	NV	Morefield S.L.	June 16
Myotis evotis	F	A	NV	Morefield S.L.	June 19
Myotis evotis	F	A	NV	Morefield S.L.	June 19
Myotis evotis	F	A	NV	Morefield S.L.	June 24
Myotis evotis	F	A	NV	Morefield S.L.	June 24
Myotis evotis	F	A	NV	Morefield S.L.	May 17
Myotis evotis	F	A	NV	Morefield S.L.	May 17
Myotis evotis	F	A	NV	Morefield S.L.	May 17
Myotis evotis	F	A	NV	Morefield S.L.	May 24
Myotis evotis	F	A	NV	Morefield S.L.	May 24
Myotis evotis	F	A	NV	Morefield S.L.	May 24
Myotis evotis	F	A	NV	Morefield S.L.	May 24
Myotis evotis	F	A	PL	Morefield S.L.	July 15
Myotis evotis	F	A	--	Morefield S.L.	June 7
Myotis evotis	M	A	NR	Morefield S.L.	July 15
Myotis evotis	M	A	NR	Morefield S.L.	July 15
Myotis evotis	M	A	NR	Morefield S.L.	July 15
Myotis evotis	M	A	NR	Morefield S.L.	Aug 9
Myotis evotis	M	A	NR	Morefield S.L.	Aug 20
Myotis evotis	M	A	NR	Morefield S.L.	July 20
Myotis evotis	M	A	NR	Morefield S.L.	July 20
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31

Myotis evotis	M	A	NV	Morefield S.L.	May 31
SPECIES	**SEX**	**AGE**	**REPRO**	**SITE**	**DATE**
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	May 31
Myotis evotis	M	A	NV	Morefield S.L.	June 16
Myotis evotis	M	A	NV	Morefield S.L.	June 16
Myotis evotis	M	A	NV	Morefield S.L.	June 16
Myotis evotis	M	A	NV	Morefield S.L.	June 16
Myotis evotis	M	A	NV	Morefield S.L.	June 16
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	June 19
Myotis evotis	M	A	NV	Morefield S.L.	May 22
Myotis evotis	M	A	--	Morefield S.L.	June 7
Myotis evotis	M	A	--	Morefield S.L.	June 7
Myotis evotis	F	A	NV	Pump Station at entrance	May 20
Myotis evotis	F	A	NV	Pump Station at entrance	May 20
Myotis evotis	F	A	NV	Wetherill S.L.	June 22
Myotis evotis	F	A	PREG	Wetherill S.L.	June 22
Myotis occultus	F	A	NR	Far View S.L.	Aug 8
Myotis occultus	F	A	NR	Far View S.L.	Aug 8

Myotis occultus	F	A	NV	Far View S.L.	May 18
Myotis occultus	F	A	NV	Far View S.L.	May 18

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis occultus	F	A	NV	Far View S.L.	May 30
Myotis occultus	F	A	NV	Far View S.L.	June 18
Myotis occultus	F	A	PREG	Far View S.L.	June 23
Myotis occultus	F	A	PREG	Far View S.L.	June 23
Myotis occultus	F	A	PREG	Far View S.L.	June 23
Myotis occultus	F	A	PREG	Far View S.L.	June 26
Myotis occultus	F	J	NR	Far View S.L.	Aug 8
Myotis occultus	M	A	NS	Far View S.L.	Aug 8
Myotis occultus	M	A	NS	Far View S.L.	Aug 8
Myotis occultus	M	A	NS	Far View S.L.	Aug 17
Myotis occultus	M	A	NV	Far View S.L.	June 15
Myotis occultus	M	A	NV	Far View S.L.	June 23
Myotis occultus	M	A	NV	Far View S.L.	June 25
Myotis occultus	M	A	SCROT	Far View S.L.	Aug 8
Myotis occultus	M	A	SCROT	Far View S.L.	Aug 8
Myotis occultus	F	A	LACT	Morefield S.L.	July 15
Myotis occultus	F	A	NR	Morefield S.L.	Aug 9
Myotis occultus	F	A	NR	Morefield S.L.	Aug 20
Myotis occultus	F	A	NR	Morefield S.L.	Aug 20
Myotis occultus	F	A	NR	Morefield S.L.	Aug 20
Myotis occultus	F	A	NR	Morefield S.L.	Aug 20
Myotis occultus	F	A	NR	Morefield S.L.	Aug 23
Myotis occultus	F	A	NV	Morefield S.L.	May 31
Myotis occultus	F	A	NV	Morefield S.L.	May 31
Myotis occultus	F	A	NV	Morefield S.L.	June 16
Myotis occultus	F	A	NV	Morefield S.L.	June 16
Myotis occultus	F	A	NV	Morefield S.L.	June 16
Myotis occultus	F	A	NV	Morefield S.L.	May 17
Myotis occultus	F	A	NV	Morefield S.L.	May 17
Myotis occultus	F	A	NV	Morefield S.L.	May 17
Myotis occultus	F	A	NV	Morefield S.L.	May 24

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis occultus	F	A	NV	Morefield S.L.	May 24
Myotis occultus	F	A	NV	Morefield S.L.	May 24
Myotis occultus	F	A	NV	Morefield S.L.	May 24
Myotis occultus	F	A	NV	Morefield S.L.	May 24
Myotis occultus	F	A	NV	Morefield S.L.	May 24
Myotis occultus	F	A	PREG	Morefield S.L.	June 24
Myotis occultus	F	A	PREG	Morefield S.L.	June 24
Myotis occultus	F	A	PREG	Morefield S.L.	June 24
Myotis occultus	M	A	NR	Morefield S.L.	Aug 20
Myotis occultus	M	A	NR	Morefield S.L.	Aug 20
Myotis occultus	M	A	NR	Morefield S.L.	Aug 20
Myotis occultus	M	A	NR	Morefield S.L.	Aug 23
Myotis occultus	M	A	NR	Morefield S.L.	Aug 23
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 16
Myotis occultus	M	A	NV	Morefield S.L.	June 19
Myotis occultus	M	A	NV	Morefield S.L.	June 19
Myotis occultus	M	A	NV	Morefield S.L.	June 19
Myotis occultus	M	A	NV	Morefield S.L.	June 19
Myotis occultus	M	A	NV	Morefield S.L.	June 24
Myotis occultus	M	J	NR	Morefield S.L.	Aug 23
Myotis sp	F	A	NV	Morefield S.L.	May 31
Myotis sp	F	A	NV	Morefield S.L.	May 31
Myotis sp	M	A	--	Morefield S.L.	June 7
Myotis thysanodes	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis thysanodes	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis thysanodes	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis thysanodes	M	A	NR	Cedar Tree Tower S.L.	July 18
Myotis thysanodes	M	A	NS	Cedar Tree Tower S.L.	July 26

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis thysanodes	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis thysanodes	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis thysanodes	F	A	NV	Far View S.L.	June 18
Myotis thysanodes	M	A	NV	Far View S.L.	June 23
Myotis thysanodes	M	A	--	Far View S.L.	June 30
Myotis thysanodes	F	A	NR	Morefield S.L.	Aug 23
Myotis thysanodes	F	A	NR	Morefield S.L.	July 20
Myotis thysanodes	M	A	NR	Morefield S.L.	July 15
Myotis thysanodes	M	A	NR	Morefield S.L.	Aug 23
Myotis thysanodes	M	A	NR	Morefield S.L.	Aug 23
Myotis thysanodes	M	A	NR	Morefield S.L.	July 20
Myotis thysanodes	M	A	NV	Morefield S.L.	June 16
Myotis thysanodes	M	A	NV	Morefield S.L.	June 19
Myotis thysanodes	M	A	NV	Morefield S.L.	June 24
Myotis volans	F	A	LACT	Cedar Tree Tower S.L.	July 7
Myotis volans	F	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 7
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 10
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 16
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	Aug 7
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 11
Myotis volans	F	A	NR	Cedar Tree Tower S.L.	July 26
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis volans	F	A	NV	Cedar Tree Tower S.L.	May 19
Myotis volans	F	A	PL	Cedar Tree Tower S.L.	July 16
Myotis volans	F	A	PL	Cedar Tree Tower S.L.	Aug 15
Myotis volans	F	A	PL	Cedar Tree Tower S.L.	Aug 15
Myotis volans	F	A	PL	Cedar Tree Tower S.L.	July 11
Myotis volans	F	A	PREG	Cedar Tree Tower S.L.	June 27
Myotis volans	F	A	PREG	Cedar Tree Tower S.L.	June 27
Myotis volans	F	A	PREG	Cedar Tree Tower S.L.	June 27
Myotis volans	F	A	PREG	Cedar Tree Tower S.L.	July 2
Myotis volans	F	A	PREG	Cedar Tree Tower S.L.	July 16
Myotis volans	F	J	NR	Cedar Tree Tower S.L.	Aug 7
Myotis volans	F	J	NR	Cedar Tree Tower S.L.	Aug 16
Myotis volans	M	A	LACT	Cedar Tree Tower S.L.	July 26
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 2
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 2
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 16
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 11
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 11

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 11
Myotis volans	M	A	NR	Cedar Tree Tower S.L.	July 11
Myotis volans	M	A	NS	Cedar Tree Tower S.L.	July 26
Myotis volans	M	A	NS	Cedar Tree Tower S.L.	July 26
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 27
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	June 27
Myotis volans	M	A	NV	Cedar Tree Tower S.L.	July 7
Myotis volans	M	A	SCROT	Cedar Tree Tower S.L.	Aug 16
Myotis volans	M	J	NR	Cedar Tree Tower S.L.	Aug 22
Myotis volans	U	A	NV	Cedar Tree Tower S.L.	June 14
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12
Myotis volans	F	A	LACT	Cliff Palace Tunnel	July 12

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	F	A	U	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NR	Cliff Palace Tunnel	July 12
Myotis volans	U	U	U	Cliff Palace Tunnel	July 12
Myotis volans	U	U	U	Cliff Palace Tunnel	July 12
Myotis volans	U	U	U	Cliff Palace Tunnel	July 12
Myotis volans	U	U	U	Cliff Palace Tunnel	July 12
Myotis volans	M	A	NV	Far View S.L	June 5
Myotis volans	F	A	LACT	Far View S.L.	June 30
Myotis volans	F	A	LACT	Far View S.L.	June 30
Myotis volans	F	A	LACT	Far View S.L.	July 14
Myotis volans	F	A	LACT	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	June 30
Myotis volans	F	A	NR	Far View S.L.	June 30
Myotis volans	F	A	NR	Far View S.L.	June 30
Myotis volans	F	A	NR	Far View S.L.	July 6
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 14
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NR	Far View S.L.	July 19
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 18
Myotis volans	F	A	NV	Far View S.L.	May 30
Myotis volans	F	A	NV	Far View S.L.	May 30
Myotis volans	F	A	NV	Far View S.L.	May 30
Myotis volans	F	A	NV	Far View S.L.	May 30
Myotis volans	F	A	NV	Far View S.L.	May 30
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 5
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 15

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NV	Far View S.L.	June 15
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 18
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 23
Myotis volans	F	A	NV	Far View S.L.	June 25

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NV	Far View S.L.	June 25
Myotis volans	F	A	NV	Far View S.L.	June 25
Myotis volans	F	A	NV	Far View S.L.	June 25
Myotis volans	F	A	NV	Far View S.L.	June 26
Myotis volans	F	A	NV	Far View S.L.	June 26
Myotis volans	F	A	NV	Far View S.L.	June 26
Myotis volans	F	A	NV	Far View S.L.	May 21
Myotis volans	F	A	NV	Far View S.L.	May 21
Myotis volans	F	A	PL	Far View S.L.	July 14
Myotis volans	F	A	PL	Far View S.L.	July 14
Myotis volans	F	A	PL	Far View S.L.	July 19
Myotis volans	F	A	PREG	Far View S.L.	June 25
Myotis volans	F	A	PREG	Far View S.L.	June 25
Myotis volans	F	A	PREG	Far View S.L.	June 26
Myotis volans	F	A	PREG	Far View S.L.	June 26
Myotis volans	F	A	PREG	Far View S.L.	June 26
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	A	PREG	Far View S.L.	June 30
Myotis volans	F	J	NR	Far View S.L.	Aug 17
Myotis volans	M	A	NR	Far View S.L.	July 14
Myotis volans	M	A	NR	Far View S.L.	July 14
Myotis volans	M	A	NR	Far View S.L.	July 14
Myotis volans	M	A	NR	Far View S.L.	July 14
Myotis volans	M	A	NR	Far View S.L.	July 19
Myotis volans	M	A	NS	Far View S.L.	Aug 14
Myotis volans	M	A	NV	Far View S.L.	May 18
Myotis volans	M	A	NV	Far View S.L.	June 15
Myotis volans	M	A	NV	Far View S.L.	June 15

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	M	A	NV	Far View S.L.	June 18
Myotis volans	M	A	NV	Far View S.L.	June 18
Myotis volans	M	A	NV	Far View S.L.	June 18
Myotis volans	M	A	NV	Far View S.L.	June 23
Myotis volans	M	A	NV	Far View S.L.	June 23
Myotis volans	M	A	NV	Far View S.L.	June 23
Myotis volans	M	A	NV	Far View S.L.	June 23
Myotis volans	M	A	NV	Far View S.L.	June 23
Myotis volans	M	A	NV	Far View S.L.	June 30
Myotis volans	M	A	NV	Far View S.L.	May 21
Myotis volans	U	A	NV	Far View S.L.	June 18
Myotis volans	F	A	PREG	Far View Visitor Center	June 30
Myotis volans	F	A	NR	Mancos River	July 22
Myotis volans	M	A	NR	Mancos River	July 22
Myotis volans	M	J	NR	Mancos River	July 22
Myotis volans	F	A	NR	Morefield S.L.	July 15
Myotis volans	F	A	NR	Morefield S.L.	July 15
Myotis volans	F	A	NR	Morefield S.L.	July 15
Myotis volans	F	A	NR	Morefield S.L.	Aug 20
Myotis volans	F	A	NR	Morefield S.L.	Aug 23
Myotis volans	F	A	NR	Morefield S.L.	Aug 23
Myotis volans	F	A	NR	Morefield S.L.	July 20
Myotis volans	F	A	NV	Morefield S.L.	May 31
Myotis volans	F	A	NV	Morefield S.L.	May 31
Myotis volans	F	A	NV	Morefield S.L.	May 31
Myotis volans	F	A	NV	Morefield S.L.	May 31
Myotis volans	F	A	NV	Morefield S.L.	June 16
Myotis volans	F	A	NV	Morefield S.L.	June 16
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 19
Myotis volans	F	A	NV	Morefield S.L.	June 24
Myotis volans	F	A	NV	Morefield S.L.	June 24
Myotis volans	F	A	NV	Morefield S.L.	June 24
Myotis volans	F	A	NV	Morefield S.L.	May 17
Myotis volans	F	A	NV	Morefield S.L.	May 17
Myotis volans	F	A	NV	Morefield S.L.	May 17
Myotis volans	F	A	PL	Morefield S.L.	July 20
Myotis volans	F	A	PL	Morefield S.L.	July 20
Myotis volans	F	A	PL	Morefield S.L.	July 20
Myotis volans	F	A	PREG	Morefield S.L.	June 24
Myotis volans	F	A	PREG	Morefield S.L.	June 24
Myotis volans	F	A	PREG	Morefield S.L.	July 5
Myotis volans	F	A	--	Morefield S.L.	June 7
Myotis volans	F	J	NR	Morefield S.L.	Aug 20
Myotis volans	M	A	NR	Morefield S.L.	July 15
Myotis volans	M	A	NV	Morefield S.L.	June 6
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 19
Myotis volans	M	A	NV	Morefield S.L.	June 24
Myotis volans	M	A	NV	Morefield S.L.	June 24
Myotis volans	M	A	--	Morefield S.L.	June 7
Myotis volans	M	A	--	Morefield S.L.	June 7

SPECIES	SEX	AGE	REPRO	SITE	DATE
Myotis volans	F	A	NV	Wetherill S.L.	June 22
Myotis volans	F	A	NV	Wetherill S.L.	June 22
Myotis volans	F	A	NV	Wetherill S.L.	June 22
Myotis volans	F	A	NV	Wetherill S.L.	June 22
Myotis volans	F	A	NV	Wetherill S.L.	June 22
Myotis volans	M	A	NV	Wetherill S.L.	June 22
Myotis yumanensis	F	A	NR	Cedar Tree Tower S.L.	July 7
Myotis yumanensis	M	A	NR	Cedar Tree Tower S.L.	July 2
Myotis yumanensis	M	A	NV	Cedar Tree Tower S.L.	June 20
Myotis yumanensis	F	A	NV	Far View S.L.	June 15
Myotis yumanensis	F	A	PREG	Far View S.L.	June 26
Myotis yumanensis	M	A	NV	Far View S.L.	May 21
Myotis yumanensis	M	A	NV	Far View S.L.	May 21
Parastrellus hesperus	F	A	PL	Cedar Tree Tower S.L.	Aug 7
Parastrellus hesperus	F	J	NR	Cedar Tree Tower S.L.	Aug 7
Parastrellus hesperus	M	A	NR	Cedar Tree Tower S.L.	July 7
Parastrellus hesperus	M	A	NR	Cedar Tree Tower S.L.	July 18
Parastrellus hesperus	M	A	NS	Cedar Tree Tower S.L.	Aug 2
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	June 14
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	June 14
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	June 20
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	June 20
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	June 27
Parastrellus hesperus	M	A	NV	Cedar Tree Tower S.L.	May 19
Parastrellus hesperus	M	J	NR	Cedar Tree Tower S.L.	July 26
Parastrellus hesperus	M	J	NR	Cedar Tree Tower S.L.	July 26
Parastrellus hesperus	--	--	--	Cedar Tree Tower S.L.	July 7
Parastrellus hesperus	M	A	NV	Far View S.L.	June 5
Parastrellus hesperus	M	A	NV	Far View S.L.	June 5
Parastrellus hesperus	M	A	NV	Far View S.L.	June 18
Parastrellus hesperus	M	A	NV	Far View S.L.	June 18
Tadarida brasiliensis	M	A	NR	Cedar Tree Tower S.L.	July 16

SPECIES	SEX	AGE	REPRO	SITE	DATE
Tadarida brasiliensis	M	A	NR	Cedar Tree Tower S.L.	Aug 22
Tadarida brasiliensis	M	A	NS	Cedar Tree Tower S.L.	Aug 16
Tadarida brasiliensis	M	A	NV	Cedar Tree Tower S.L.	June 20
Tadarida brasiliensis	M	A	NV	Cedar Tree Tower S.L.	June 20
Tadarida brasiliensis	M	A	NR	Far View S.L.	July 14

Appendix III.2. General characterizations of habitat, vegetation zones, elevation ranges, and roosting habits of the species of bats documented at Mesa Verde in 2006, primarily as described by regional faunal manuals of the Four Corners states.

Species	General habitat preferences
Antrozous pallidus	•"Semi-desert and montane shrublands, piñon-juniper woodlands, and riparian woodland in foothills and canyon country. Cliff faces with crevices and fissures…are needed for day roosts" (Fitzgerald and others, 1994). •"Generally below 6,000 ft in elevation [in Colo]" (Armstrong and others, 1994). • "Most common at lower elevations and may be found in deserts and grasslands…where rock outcrops interrupt the desert terrain, the animals may be quite common" (Findley and others, 1975). • "inhabitants of the desertscrub" (Hoffmeister, 1986). • "At lower, more arid sites in Utah, it is often one of the 3 most abundant bat species, but at higher elevations it is rarer" (Oliver, 2000).
Corynorhinus townsendii	• "coniferous forest and woodland, deciduous riparian woodland, and semidesert and montane shrublands. More important than vegetation surely is physical habitat, especially the presence of caves or mines suitable for day and night roosting and for hibernation" (Armstrong and others, 1994). • "During the summer single individuals may be found hanging in cracks of cliffs" (Fitzgerald

	and others, 1994). • "In summer…can be found over desertscrub, in sheleters in desert-mountains, oak-woodland, piñon-juniper, or coniferous forests" (Hoffmeister, 1986). • "caves, rock shelters, or mines…low, arid desert situations to Canadian Zone conditions" (Findley and others, 1975).
Eptesicus fuscus	• "most common in ponderosa pine forest, and many are also taken in piñon-juniper woodland" (Findley and others. 1975). • "This bat is found in almost every habitat in the United States….roost in dwellings and other structures, in hollow trees, rock crevices, caves, under bridges, and in practically any other location that offers concealment and cover from the elements" (Fitzgerald and others, 1994). • "Commonly found in the wooded areas, deciduous and coniferous, but they are also present in the desertscrub" (Hoffmeister, 1986).
Euderma maculatum	• "captured…in several habitats: lowland riparian habitat in the desert shrub community, sagebrush–rabbitbrush, ponderosa pine forest, montane grassland…, and montane forest and woodland" (Oliver, 2000). • First specimens from "piñon-juniper woodland in an area of spectacular sandstone cliffs;" "ponderosa or mixed coniferous forest… [near] rock cliffs" (Findley and others, 1975). • "mostly from ponderosa pine and piñon-juniper woodlands…roosts are in cracks in cliffs" (Armstrong and others, 1994). • "The literature gives the impression that cliffs and rocks are a dominant habitat requirement" (Hoffmeister, 1986).

Lasiurus cinereus	• “uses a variety of trees as roost sites…in Colorado…is frequently taken in ponderosa pine forests…never seems to be abundant in any area” (Fitzgerald and others, 1994). • “lowland riparian, desert shrub, sagebrush-greasewood (near piñon-juniper), lodgepole pine forest, montane grassland…, and montane forest and woodland… also known from towns and cities…elevational range…to 9,200 ft” (Oliver, 2000). • “During the daytime they hang in the dense foliage” (Hoffmeister, 1986).
Lasionycteris noctivagans	• “thought to use tree cavities or crevices under loose bark for summer roosts…In summer, males tend to stay at higher elevations in the Rocky Mountains while females move farther north to rear their young” (Fitzgerald and others, 1994; see also Cryan, 2003). • “roost in cavities and beneath loose bark of both deciduous and coniferous trees, at elevations to 10,000 feet” (Armstrong and others, 1994). •”lowland riparian and desert shrub to montane forest… to 9,760 ft” (Oliver, 2000).
Myotis californicus	• “inhabitants of the brushy, desert, or grassy areas…and do not occur often in the ponderosa or spruce-fir forests” (Hoffmeister, 1986). • “Elevational range is to about 7400 ft. General habitat… in Colorado is semi-desert shrublands and piñon-juniper woodlands” (Armstrong and others, 1994). • Roosts in “abandoned structures, mines, caves, and cracks and crevices in cliff faces...hollow trees and spaces under bark” (Fitzgerald and others, 1994). •”locally common from grassland and desert through the ponderosa pine zone…may similarly [to pipistrelles] be dependent on cliffs and other sorts of rocky areas for shelter” (Findley and others, 1975).

Myotis ciliolabrum

• “inhabits a variety of habitats including: lowland riparian, desert shrub, juniper-sagebrush, juniper, piñon–juniper, sagebrush-rabbitbrush, sagebrush-greasewood (near piñon-juniper), highland riparian in lodgepole pine forest, montane forest and woodland” (Oliver, 2000).

• “center of distribution…seems to be in the ponderosa pine zone, although the animals occur as low as desert and as high as the lower edges of the spruce-fir zone” (Findley and others, 1975).

•”low to moderate elevations…to as high as …9500 ft in the LaPlata Mountains…Day roosts are various, including cracks and crevices in cliffs, beneath tree bark, in mines and caves” (Armstrong and others, 1994).

Myotis evotis

• “coniferous woodlands and forests, especially ponderosa pine and piñon-juniper communities. Roosts…include tree hollows, beneath loose bark” (Armstrong and others, 1994).

• “coniferous forests at moderate elevations” (Fitzgerald and others, 1994).

• “lowland riparian and sagebrush to montane forest…elevational range 4,700 to 9,500 ft” (Oliver, 2000).

Myotis occultus

• “roosting by day under bark, in trees, under rocks, in wood piles, buildings and other structures” (Fitzgerald and others, 1994).

• “Vegetation zone seems unimportant in determining their distribution” (Findley and others, 1975).

• “In Arizona is usually found in the ponderosa pine or oak-pine woodland” (Hoffmeister and others, 1986).

Myotis thysanodes

• “records scattered at moderate elevations (about 5000–8000 ft.)…a species of coniferous

	woodlands" (Armstrong and others, 1994).
	• "Yellow pine zone down into the grassland…recorded roosting and breeding in caves and buildings" (Findley and others, 1975).
	• "apparently is not common in Colorado. It is found in ponderosa pine woodlands, greasewood, oak-brush, and saltbush shrublands" (Fitzgerald and others, 1975).
Myotis volans	• "mostly at moderate elevations, but ranging to nearly 11,500 ft…coniferous woodland and forest, especially ponderosa pine and piñon-juniper communities, although they do range higher…roosts include buildings, trees, and crevices in rocks" (Armstrong and others, 1994).
	• "This is the common *Myotis* of the western United States and over large areas is probably the most abundant species" (Barbour and Davis, 1969).
	• "Ponderosa pine zone or above" (Findley and others, 1975).
Myotis yumanensis	• "roost by day in rock crevices, buildings, caves and mines, and swallow nests…frequently associated with semi-arid canyons and mesas at lower elevations in southern and western Colorado" (Fitzgerald and others, 1994).
	• "distribution is tied to permanent watercourses, usually below the coniferous forest zone. In New Mexico the zonal center of abundance...seems to be in desert, grassland, and woodland, and the riparian communities of these zones, from 4,000 to 7,000 feet" (Findley and others, 1975).
Parastrellus hesperus	• "one of the more common bats in canyon and desert country" (Fitzgerald and others, 1994).
	• "a bat of woodlands and shrublands in canyon country, where it roosts...beneath boulders or in cracks and crevices in cliff faces" (Armstrong and others, 1994).

	• "desertscrub to the pine forest, but never far from rocky canyon walls, cliffs, or rocky outcrops where they roost during the day" (Hoffmeister, 1986). •"usually found in the vicinity of rock cliffs where they doubtless seek shelter during the day…of the specimens we have collected, approximately 63 percent came from grassland and desert, 35 percent came from woodland (piñon-juniper and oak encinal)" (Findley and others, 1975).
Tadarida brasiliensis	• "Most occur below 6,000 feet in piñon-juniper woodland, desert grassland, or desert communities. Roosts are in caves, rock fissures, bridges, or buildings" (Findley and others, 1975). • "In the southwestern United States…occurs at lower elevations, in piñon-juniper woodlands, arid grasslands, and semidesert shrublands" (Fitzgerald and others, 1994).

Appendix III.3. Specimen records of bats from Mesa Verde National Park (MEVE), housed in the U.S. Geological Survey's Biological Survey Collection, Museum of Southwestern Biology (MSB). All vouchers are regarded as skin and skull specimens except MSB catalog numbers with asterisks. A single asterisk represents vouchers as skull and post-cranial skeleton only; two asterisks denote individuals preserved in alcohol; three asterisks represent specimens as skull, post-cranial skeleton and skin. Approximate elevation was read from topographic maps for this report and should be considered provisional. Additional information regarding preparer, collector's catalog number, and other data are available from the Museum and in a spreadsheet database that will be provided to MEVE with the final report.

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
Myotis californicus	Spring, Lower Morefield Canyon	- -	5-Aug-89	F	114296	MEVE 51460	Lactating
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114393	MEVE 51564	
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114394	MEVE 51565	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114395	MEVE 51599	
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117085	MEVE 57003	No emb
	Wetherill Mesa, Limey Draw	- -	15-Aug-89	F	114432	MEVE 51623	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114893	MEVE 52361	
	East Escarpment, Big Hill, Cortez Windy Point	- -	11-Apr-90	M	114983*	MEVE 52297	
Myotis californicus	B-cut	- -	6-May-87	M	114984*	MEVE 52298	
	Spring, lower Morefield Canyon	- -	27-Jul-91	F	117046	MEVE 56307	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118936	MEVE 61314	Testes 1 x 3

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
Myotis ciliolabrum	Morefield Canyon, approx. 3 mi S Morefield Village	- -	6-Jun-90	M	114848	MEVE 52320	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	F	114849	MEVE 52347	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	116998	MEVE 56270	Testes 3 x 2
	Rock Springs	- -	3-Aug-91	M	117061	MEVE 57061	Testes 4 x 2
Myotis evotis	Spring, Lower Morefield Canyon	- -	5-Aug-89	F	114298	MEVE 51461	
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114396	MEVE 51566	
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114397	MEVE 51567	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114398	MEVE 51568	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114399	MEVE 51569	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114400	MEVE 51570	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114401	MEVE 51571	
	1 mi SSE Rock Springs	2,256	14-Aug-89	M	114402	MEVE 51600	
Myotis evotis	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114403	MEVE 51601	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114404	MEVE 51602	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114405	MEVE 51603	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114406	MEVE 51604	
	1 mi SSE Rock Springs	2,256	13-Aug-89	F	114412	MEVE 51592	
	Wetherill Mesa, Limey Draw	- -	16-Aug-89	F	114433	MEVE 51632	
	Morefield Canyon, approx.	- -	6-Jun-90	M	114850	MEVE 52321	

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	3 mi S Morefield Village						
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	6-Jun-90	F	114851	MEVE 52322	1 emb 10mm
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	6-Jun-90	F	114852	MEVE 52323	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	7-Jun-90	F	114853	MEVE 52342	1 emb 12mm
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	M	114854	MEVE 52348	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	M	114855	MEVE 52349	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	F	114856	MEVE 52350	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	F	114857	MEVE 52351	1 emb 8 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114894*	MEVE 52362	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114895	MEVE 52363	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114896*	MEVE 52364	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114897	MEVE 52365	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114898*	MEVE 52366	1 emb x 11mm
Myotis evotis	Wetherill Mesa, Limey Draw	- -	11-Jun-90	M	114925	MEVE 52382	
	Wetherill Mesa, Limey Draw	- -	12-Jun-90	F	114926	MEVE 52398	

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	Long House	- -	6-Jun-83	F	114985*	MEVE 52294	
	Chapin Mesa, Far View Visitor Center	- -	3-Oct-85	F	114986*	MEVE 52295	
	Whites Canyon, 0.3 mi ENE Whites Mesa Lookout Tower	- -	21-Jul-91	F	116905	MEVE 56116	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	116999	MEVE 56271	Testes 4 x 2
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117000	MEVE 56272	Testes 4 x 3
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117001	MEVE 56273	Testes 5 x 3
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117002	MEVE 56274	Testes 2 x 1
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117003	MEVE 56275	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117004	MEVE 56276	Testes 3 x 2
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117005*	MEVE 56277	Testes 3 x 2
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117006	MEVE 56279	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117007	MEVE 56280	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117008	MEVE 56281	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117009	MEVE 56282	No emb
	Morefield Canyon, approx.	- -	27-Jul-91	F	117010	MEVE 56283	No emb

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	3 mi S Morefield Village						
Myotis evotis	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117011	MEVE 56284	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117012	MEVE 56285	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117013*	MEVE 56286	No emb
	Spring, lower Morefield Canyon	- -	27-Jul-91	M	117047	MEVE 56308	Testes 4 x 2
	Spring, lower Morefield Canyon	- -	27-Jul-91	F	117048	MEVE 56309	No emb
	Rock Springs	- -	3-Aug-91	F	117062	MEVE 57062	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117086	MEVE 57004	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117087	MEVE 57005	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117088	MEVE 57006	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117089	MEVE 57007	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117090	MEVE 57008	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117091	MEVE 57009	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117092	MEVE 57010	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117093	MEVE 57011	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117094	MEVE 57012	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117095	MEVE 57013	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117096	MEVE 57014	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117097	MEVE 57015	No emb; epiphysis unfused

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
Myotis evotis	1 mi SSE Rock Springs	2,256	3-Aug-91	M	117098	MEVE 57055	Testes 3 x 2
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117246**	MEVE 56278	91-44-8-21=4
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117247**	MEVE 56287	97-50-9-22=4
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117248**	MEVE 56288	90-44-8-21=4
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118937	MEVE 61315	Testes 1 x 3
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118938	MEVE 61316	Testes 1 x 3
	Morefield Canyon, Sewage Disposal Ponds	- -	1-Aug-94	F	121593	MEVE 67863	No embs
	Morefield Canyon, Sewage Disposal Ponds	- -	1-Aug-94	M	121594	MEVE 67864	Testes 3 x 6
	Morefield Canyon, Sewage Disposal Ponds	- -	1-Aug-94	M	121595	MEVE 67865	Testes 3 x 5
	Morefield Canyon, Sewage Disposal Ponds	- -	1-Aug-94	F	121596	MEVE 67866	No embs
	Spring, Lower Morefield Canyon	- -	4-Aug-89	F	114297	MEVE 51448	
Myotis occultus	Morefield Canyon, Sewage Disposal Ponds	- -	28-Aug-92	M	118933	MEVE 61317	Testes 2 x 4
Myoti thysanodes	Spring, Lower Morefield Canyon	- -	4-Aug-89	M	114299	MEVE 51449	

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	Spring, Lower Morefield Canyon	- -	4-Aug-89	F	114300	MEVE 51450	
Myotis thysanodes	Rock Springs	- -	3-Aug-91	F	117063	MEVE 57063	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	M	117099	MEVE 57016	Testes 3 x 1
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117100	MEVE 57017	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117101	MEVE 57018	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117102	MEVE 57019	No emb
	1 mi SSE Rock Springs	2,256	3-Aug-91	F	117103	MEVE 57056	No emb
	Spruce Canyon, 0.1 mi N jct Spruce Tree Canyon	- -	29-Aug-92	M	118950	MEVE 61324	Testes 4 x 6
Myotis volans	Spring, Lower Morefield Canyon	- -	4-Aug-89	F	114301	MEVE 51451	
	Spring, Lower Morefield Canyon	- -	5-Aug-89	F	114302	MEVE 51462	
	Spring, Lower Morefield Canyon	- -	5-Aug-89	F	114303	MEVE 51463	
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114407	MEVE 51572	
	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114408	MEVE 51573	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114409	MEVE 51574	
	1 mi SSE Rock Springs	2,256	12-Aug-89	F	114410	MEVE 51575	
	1 mi SSE Rock Springs	2,256	14-Aug-89	M	114411	MEVE 51605	
	1 mi SSE Rock Springs	2,256	14-Aug-89	M	114413	MEVE 51606	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114414	MEVE 51607	

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	Wetherill Mesa, Limey Draw	- -	15-Aug-89	M	114434	MEVE 51624	
	Wetherill Mesa, Limey Draw	- -	15-Aug-89	F	114435	MEVE 51625	
Myotis volans	Wetherill Mesa, Limey Draw	- -	15-Aug-89	F	114436	MEVE 51626	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114899	MEVE 52367	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114900	MEVE 52368	1 emb x 6 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114901*	MEVE 52369	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114902	MEVE 52370	1 emb x 4 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114903	MEVE 52371	
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114904*	MEVE 52372	1 emb x 8 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114905*	MEVE 52373	2 emb x 8 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114906	MEVE 52374	1 emb x 7 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114907	MEVE 52375	1 emb x 4 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114908	MEVE 52376	1 emb x 4 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114909	MEVE 52377	1 emb x 7 mm
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	F	114910	MEVE 52378	1 emb x 5 mm

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	Wetherill Mesa, Limey Draw	- -	11-Jun-90	F	114927	MEVE 52383	1 emb x 7 mm
	Wetherill Mesa, Limey Draw	- -	11-Jun-90	F	114928	MEVE 52384	1 emb x 4 mm
	Wetherill Mesa, Limey Draw	- -	11-Jun-90	F	114929	MEVE 52385	1 emb x 3 mm
	Wetherill Mesa, Limey Draw	- -	12-Jun-90	F	114930	MEVE 52399	
	Chapin Mesa, Cliff Palace trail	- -	13-Aug-82	F	114989*	MEVE 52300	
Myotis volans	Long Canyon, Step House entrance trail	- -	26-Aug-86	M	114990*	MEVE 52301	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	117014	MEVE 56289	Testes 3 x 2
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117015	MEVE 56290	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117016	MEVE 56291	No emb
	Spring, lower Morefield Canyon	- -	27-Jul-91	F	117049	MEVE 56310	1 emb x 15
	Rock Springs	- -	3-Aug-91	M	117064	MEVE 57064	Testes 3 x 2
	Rock Springs	- -	3-Aug-91	F	117065	MEVE 57065	No emb
	Rock Springs		3-Aug-91	F	117066	MEVE 57174	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	M	117104	MEVE 57020	Testes 2 x 1; epiphysis unfused
	1 mi SSE Rock Springs	2,256	2-Aug-91	M	117105	MEVE 57021	Testes 2 x 1; epiphysis unfused
	1 mi SSE Rock Springs	2,256	2-Aug-91	M	117106	MEVE 57022	Testes 2 x 1; epiphysis unfused

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	1 mi SSE Rock Springs	2,256	2-Aug-91	M	117107	MEVE 57023	Testes 2 x 1; epiphysis unfused
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117108	MEVE 57024	No emb
Myotis volans	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117109	MEVE 57025	Lact/no emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117110	MEVE 57026	Lact/no emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117111	MEVE 57027	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117112	MEVE 57028	No emb; epiphysis unfused
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117113	MEVE 57029	No emb; epiphysis unfused
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117114	MEVE 57030	No emb; epiphysis unfused
	1 mi SSE Rock Springs	2,256	3-Aug-91	M	117115	MEVE 57057	Testes 7 x 5
	1 mi SSE Rock Springs	2,256	3-Aug-91	F	117116	MEVE 57058	Lact/no emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118939	MEVE 61318	No data
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	F	118940	MEVE 61319	No data
	Morefield Canyon, approx. Sewage Disposal Ponds	- -	1-Aug-94	M	121597	MEVE 67867	Testes 2 x 5
	Morefield Canyon, approx. Sewage Disposal Ponds	- -	1-Aug-94	M	121598	MEVE 67868	Testes 3 x 5
	Morefield Canyon, 100 yds	- -	9-Jul-87	F	114987*	MEVE 52296	

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
	E tunnel						
***Myotis* sp.**	Chapin Mesa, Cliff Palace	- -	15-Jun-92	F	121724***	MEVE 68076	M-98; no repro data
	Chapin Mesa, Chapin Mesa Post Office lobby	- -	31-Jul-90	M	121725*	MEVE 68087	M-84; juv/no repro data
	(Chapin Mesa), Far View	- -	9-Aug-91	M	121726*	MEVE 68088	B-61; no repro data
	Mesa Verde National Park	- -	before 1 Mar 2005	N/A	121727*	MEVE 68089	M-95; no repro data
	Chapin Mesa	- -	17-Jul-90	M	121728***	MEVE 68090	M-85, no repro data
Corynorhinus townsendii	Spring, Lower Morefield Canyon	- -	4-Aug-89	F	114304	MEVE 51452	
	Spring, Lower Morefield Canyon	- -	6-Aug-89	F	114305	MEVE 51473	Lactating
	1 mi SSE Rock Springs	2,256	13-Aug-89	F	114416	MEVE 51593	
	1 mi SSE Rock Springs	2,256	13-Aug-89	M	114417	MEVE 51594	
	1 mi SSE Rock Springs	2,256	14-Aug-89	F	114418	MEVE 51608	
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117117	MEVE 57031	Lact/no emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117118	MEVE 57032	Lact/no emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117119	MEVE 57033	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117120	MEVE 57034	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117121	MEVE 57035	No emb
	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117122	MEVE 57036	No emb
	1 mi SSE Rock Springs	2,256	3-Aug-91	F	117123	MEVE 57060	Lact/no emb

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
Corynorhinus townsendii	1 mi SSE Rock Springs	2,256	2-Aug-91	F	117251**	MEVE 57037	99-53-9-36=7
	Wetherill Mesa, Limey Draw	- -	15-Aug-89	F	114437	MEVE 51627	
	Wetherill Mesa, Limey Draw	- -	16-Aug-89	F	114438	MEVE 51633	
	Wetherill Mesa, Limey Draw	- -	16-Aug-89	F	114439	MEVE 51634	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117017	MEVE 56295	No emb
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	F	117018	MEVE 56296	No emb
	Navajo Canyon, near Echo Cliffs	- -	29-Aug-92	F	118949	MEVE 61336	No emb
	Whites Canyon, 0.3 mi ENE Whites Mesa Lookout Tower	- -	21-Jul-91	F	116906	MEVE 56117	Post-lactating
Eptesicus fuscus	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	116995	MEVE 56294	Testes 9 x 5
	1 mi SSE Rock Springs	2,256	3-Aug-91	M	117084	MEVE 57059	Testes 8 x 3
Lasionycteris noctivagans	1 mi SSE Rock Springs	2,256	12-Aug-89	M	114415	MEVE 51576	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	8-Jun-90	M	114847	MEVE 52352	
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	116996	MEVE 56292	Testes 6 x 3
	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118934	MEVE 61320	Testes 4 x 7

Scientific name	Locality	Approx elevation (m)	Date	Sex	MSB catalog no.	NPS catalog no.	Misc., repro.
Lasionycteris noctivagans	Morefield Canyon, approx. 3 mi S Morefield Village	- -	28-Aug-92	M	118935	MEVE 61321	Testes 4 x 7
	Morefield Canyon, 1 mi N spring	- -	9-Jun-90	M	114892	MEVE 52379	
Lasiurus cinereus	Morefield Canyon, approx. 3 mi S Morefield Village	- -	27-Jul-91	M	116997	MEVE 56293	Testes 6 x 3
Antrozous pallidus	Wetherill Mesa, Limey Draw	- -	13-Jun-90	F	114931	MEVE 52410	

Appendix III.4. Specimen records of bats from Mesa Verde National Park (MEVE) and surrounding areas in Montezuma, La Plata, Dolores, and San Juan Counties. This list is based on records summarized from Armstrong and others (1994)†, searches of museum databases, unpublished sources including a U.S. Geological Survey bat inventory at Yucca House National Monument by E.W. Valdez, reports based on Colorado Department of Health (CDOH) rabies exposure samples, cited literature, or personal observations. Museum specimens are housed in multiple collections that include Denver Museum of Natural History (DMNH), United States National Museum (USNM), University of Kansas (KU), Museum of Southwestern Biology (MSB), and American Museum of Natural History (AMNH).

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
Myotis californicus	Montezuma	Ashbaugh's Ranch [Moqui]	USNM	3	
		Rock Springs, Mesa Verde National Park, 7,400 ft	KU	2	
		Loop road, 1 1/2 mi S Park Headquarters	KU	1	
		Mesa Verde National Park	DMNH	1	
	La Plata	Burnwell Mine and Peakcock mines, sec. 29, T35N, R11W			Freeman and Adams (1992)††
Myotis californicus	La Plata	37° 01' 25"N, 107° 29' 09"W			Natural Heritage Inventory—MSB
Myotis ciliolabrum	Montezuma	Rock Srpings, 7,400 ft, Mesa Verde National Park	KU	5	
		Ruins Road, 1 1/2 mi S Park Headquarters	KU	3	
		Loop Road, 1 1/2 mi S Park	KU	4	

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
		Headquarters			
		Mesa Verde National Park	DMNH	1	
		East of Ismay Ranch, 0708630E, 4123681N			Yucca House Inventory (E. Valdez, 2001)
		North Pond West of Ismay House, 0706113E, 4126626N			Yucca House Inventory (E. Valdez, 2001)
	La Plata	Allison	MSB	1	
Myotis evotis	Montezuma	Ashbaugh's Ranch [Moqui]	USNM	1	
		Rock Springs, Mesa Verde National Park, 7,400 ft	KU	2	
		Museum, Mesa Verde National Park, 6,950 ft	KU	1	
		South Pond West of Ismay House, 705139E, 4124987N	MSB	1	Yucca House Inventory (E. Valdez, 2001)
		Middle Pond on Ismay Ranch, 705497E, 4126207N	MSB	1	Yucca House Inventory (E. Valdez, 2001)
		East of Ismay Ranch, 0708630E, 4123681N			Yucca House Inventory (E. Valdez, 2001)
		Dolores			Miller and Allen (1928)[†††]
		Chickaree Draw, Prater Canyon, Mesa Verde National Park			Anderson (1961)[††††]
	La Plata	No locality other than county	CDOH	1	
Myotis	La Plata	Peakcock Mine, sec. 29, T35N,			Freeman and Adams

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
evotis		R11W			(1992)††
Myotis occultus	Montezuma	5 mi N, 2 mi W Dolores, 6,750 ft	MSB	14	
	La Plata	Bell, 13 mi N Durango, T37N, R9W,	CDOH	4	
		Durango	CDOH	1	
		37° 01' 25"N, 107° 29' 09"W			Durrant and Dean (1961)†††††
Myotis thysanodes	Montezuma	Rock Springs, 7,400 ft, Mesa Verde Natoinal Park	KU	1	
		East of Ismay Ranch, 0708630E, 4123681N			Yucca House Inventory (E. Valdez, 2001)
	La Plata	Peacock Mine, sec. 29, T35N, R11W			Freeman and Adams (1992)††
Myotis volans	Montezuma	Cahone Canyon, 4 mi SW Cahone, T39N, R18W	KU	1	
		Yellowjacket Canyon, 1 mi NE Ismay Trading Post, T36N, R20W	KU	1	
		Rock Springs, Mesa Verde National Park, 7,400 ft	KU	1	
		South Pond West of Ismay House, 705139E, 4124987N			Yucca House Inventory (E. Valdez, 2001)
		Middle Pond on Ismay Ranch, 705497E, 4126207N			Yucca House Inventory (E. Valdez, 2001)

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
	La Plata	26 mi N Bayfield	AMNH	1	
		Peacock Mine, sec 29, T35N, R11W			Freeman and Adams (1992)††
Myotis yumanensis	La Plata	Florida River, 12 mi S Durango, T33N, R9W	MSB	1	
		Allison	MSB	2	
Lasiurus cinereus	Montezuma	4 mi SW Cahone, Cahone Canyon, R18W, T39N	KU	2	
		McElmo Canyon, 11 mi W cortez, R18W, T36N	KU	1	
		1/2 mi N North Rim, Chapin Mesa, Mesa Verde National Park	KU	1	
		Middle Pond on Ismay Ranch, 705531E, 4126221N			Yucca House Inventory (E. Valdez, 2001)
	La Plata	Allison	MSB	2	
Lasionycteris noctivagans	Montezuma	4 mi SW Cahone, Cahone Canyon, R18W, T39N	KU	1	
		11 mi W Cortez, McElmo Canyon, R18W, T36	KU	2	
		1 mi NE of Ismay Trading Post, Yellowjacket Canyon, T36N, R20W	KU	1	
		9 mi SW Towaoc, Mountain Ute Indian Reservation, R19W, T34N	KU	3	

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
Lasionycteris noctivagans	La Plata	Florida	AMNH	2	
		12 Mi S Durango, Florida River	DMNH	2	
		Bondad	DMNH	1	
Parastrellus hesperus	Montezuma	Ashbaugh's Ranch [Moqui]	USNM	1	
		Ruins Road, 1 mi S Headquarters, 6,900 ft, Mesa Verde National Park	KU	1	
		Loop Road, 1 1/2 mi S Headquarters	KU	2	
		Mesa Verde National Park	DMNH	1	
		Yellowjacket Canyon, 1 mi NE Ismay trading post, R20W, T36N	KU	4	
Parastrellus hesperus		McElmo Canyon, 11 mi W Cortez, R18W, T36N	KU	1	
		Four Corners	DMNH	8	
Eptesicus fuscus	Montezuma	Cahone Canyon, 4 mi SW Cahone, T39N, R18W	KU	1	
		McElmo Canyon, 11 mi W Cortez, T36N, R18W	KU	1	
		South Pond West of Ismay House,			Yucca House Inventory

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
		705139E, 4124987N			(E. Valdez, 2001)
		Middle Pond on Ismay Ranch, 705531E, 4126221N			Yucca House Inventory (E. Valdez, 2001)
		East of Ismay Ranch, 0708630E, 4123681N			Yucca House Inventory (E. Valdez, 2001)
		Rock Springs, Mesa Verde National Park	KU	1	
Eptesicus fuscus	La Plata	Florida	AMNH	1	
		Florida River, 12 mi S Durango, T33N, R9W	MSB		
		Peacock Mine, sec. 29, T35N, R11W			Freeman and Adams (1992)††
Corynorhinus townsendii	Montezuma	1 mi NE Ismay Trading Post, R20W, T36N	KU	1	
		Rock Springs, 7,400 ft, Mesa Verde National Park	KU	1	
		Square Tower House, 6,700 ft	KU	1	
		Simon Draw, NW1/4 NE1/4 SW1/4 sec4, T36N, R15W			D. M. Armstrong
		Red Arrow Mine, 9,500 ft			D. M. Armstrong
		Rudd Maybe Mine			D. M. Armstrong
	La Plata	18 mi S of Hesperus, McDermott Arroyo, T23N, R11W	KU	1	

Genus species	County	Locality	Collection	Number of specimens	Literature and(or) observations
Euderma maculatum	Montezuma	North Pond West of Ismay House, 0706113E, 4126626N			Yucca House Inventory (E. Valdez, 2001)
		Middle Pond on Ismay Ranch, 705531E, 4126221N			Yucca House Inventory (E. Valdez, 2001)
Antrozous pallidus	Montezuma	Ashbaugh's Ranch [Moqui]	USNM	2	
Tadarida brasiliensis	Montezuma	Probably in or near Cortez			D.M. Armstrong
		Cliff "Place," 6,800 ft, Mesa Verde National Park			Anderson (1961)[††††]
	La Plata	Fort Lewis College			JF
Nyctinomops macrotis	Montezuma	Captured at Mancos River, radiotagged. In daytime signal estimated to be transmitting from presumed roost in cliffs east of park boundary in T35NR14W S36 (within 0.5 km of UTM 12N 735894, 4125105)			Chung-MacCoubrey and Philbrook, U.S. Forest Service

[†] Armstrong, D.M., Adams, R.A., and Freeman, J., 1994, Distribution and ecology of bats of Colorado: Natural History Inventory of Colorado, no. 15, 83 p.

[††] Freeman, J., and Adams, R.A., 1992, Project report. Conservation of Colorado's bat fauna—The effects of gating inactive mines on bat activity: Denver, Colo., Processed report to Colorado Division of Wildlife, 17 p.

[†††] Miller, G.S., Jr., and Allen, G.M., 1928, The American bats of the genera *Myotis* and *Pizonyx*: Bulletin of the United States National Museum, v. 144, p. viii + 1–218.

†††† Anderson, S., 1961, Mammals of Mesa Verde National Park: University of Kansas Publications, Museum of Natural History, v. 14, p. 29–67.

††††† Durrant, S.D., and Dean, N.K., 1961, Mammals of the Navajo Reservoir Basin, 1960: Anthropological Papers, University of Utah, v. 48, p. 209–235.

Appendix IV.1. Adult bats tagged with radio transmitters during 2006 at Mesa Verde National Park. Showing species, sex, reproductive status (rep: U = unknown, P = pregnant, L = lactating, PL = postlactating, NR = non-reproductive), date of capture (Date), site of capture (Tagging site), and number of roosts found (N roosts).

Species	Sex	Rep	Date	Tagging site	N roosts
Corynorhinus townsendii	F	U	14-Jun	CEDAR TREE SL	0
Corynorhinus townsendii	F	L	7-Jul	CEDAR TREE SL	0
Euderma maculatum	F	P	27-Jun	CEDAR TREE SL	1
Euderma maculatum	F	L	30-Jun	FAR VIEW SL	1
Euderma maculatum	F	L	20-Jul	MOREFIELD SL	3
Myotis evotis	F	U	16-Jun	MOREFIELD SL	5
Myotis evotis	F	U	17-Jun	MOREFIELD SL	1
Myotis evotis	F	U	18-Jun	FAR VIEW SL	0
Myotis evotis	F	U	18-Jun	FAR VIEW SL	1
Myotis evotis	F	U	19-Jun	MOREFIELD SL	0
Myotis evotis	F	L	30-Jun	FAR VIEW VC	5
Myotis evotis	F	L	7-Jul	FAR VIEW VC	7
Myotis evotis	F	PL	14-Jul	FAR VIEW SL	2
Myotis evotis	F	L	14-Jul	FAR VIEW SL	0
Myotis evotis	F	L	14-Jul	FAR VIEW SL	7
Myotis evotis	F	PL	14-Jul	FAR VIEW SL	0
Myotis evotis	F	L	16-Jul	CEDAR TREE SL	0
Myotis evotis	F	L	26-Jul	CEDAR TREE SL	0
Myotis evotis	F	P	30-Jun	FAR VIEW SL	0
Myotis occultus	F	P	16-Jun	MOREFIELD SL	3
Myotis occultus	F	P	24-Jun	MOREFIELD SL	2
Myotis occultus	F	P	24-Jun	MOREFIELD SL	2
Myotis occultus	F	P	26-Jun	FAR VIEW SL	1
Myotis occultus	F	L	15-Jul	MOREFIELD SL	1
Myotis thysanodes	F	L	12-Jul	CLIFF PALACE TUN.	1
Myotis thysanodes	F	NR	20-Jul	MOREFIELD SL	0
Myotis volans	F	P	25-Jun	FAR VIEW SL	0
Myotis volans	F	P	25-Jun	FAR VIEW SL	3
Myotis volans	F	P	26-Jun	FAR VIEW SL	0
Myotis volans	F	P	26-Jun	FAR VIEW SL	0
Myotis volans	F	P	27-Jun	CEDAR TREE SL	1
Myotis volans	F	P	27-Jun	CEDAR TREE SL	2
Myotis volans	F	L	12-Jul	CLIFF PALACE TUN.	1
Myotis volans	F	L	12-Jul	CLIFF PALACE TUN.	1
Myotis volans	F	L	14-Jul	FAR VIEW SL	0
Myotis yumanensis	F	P	26-Jun	FAR VIEW SL	0

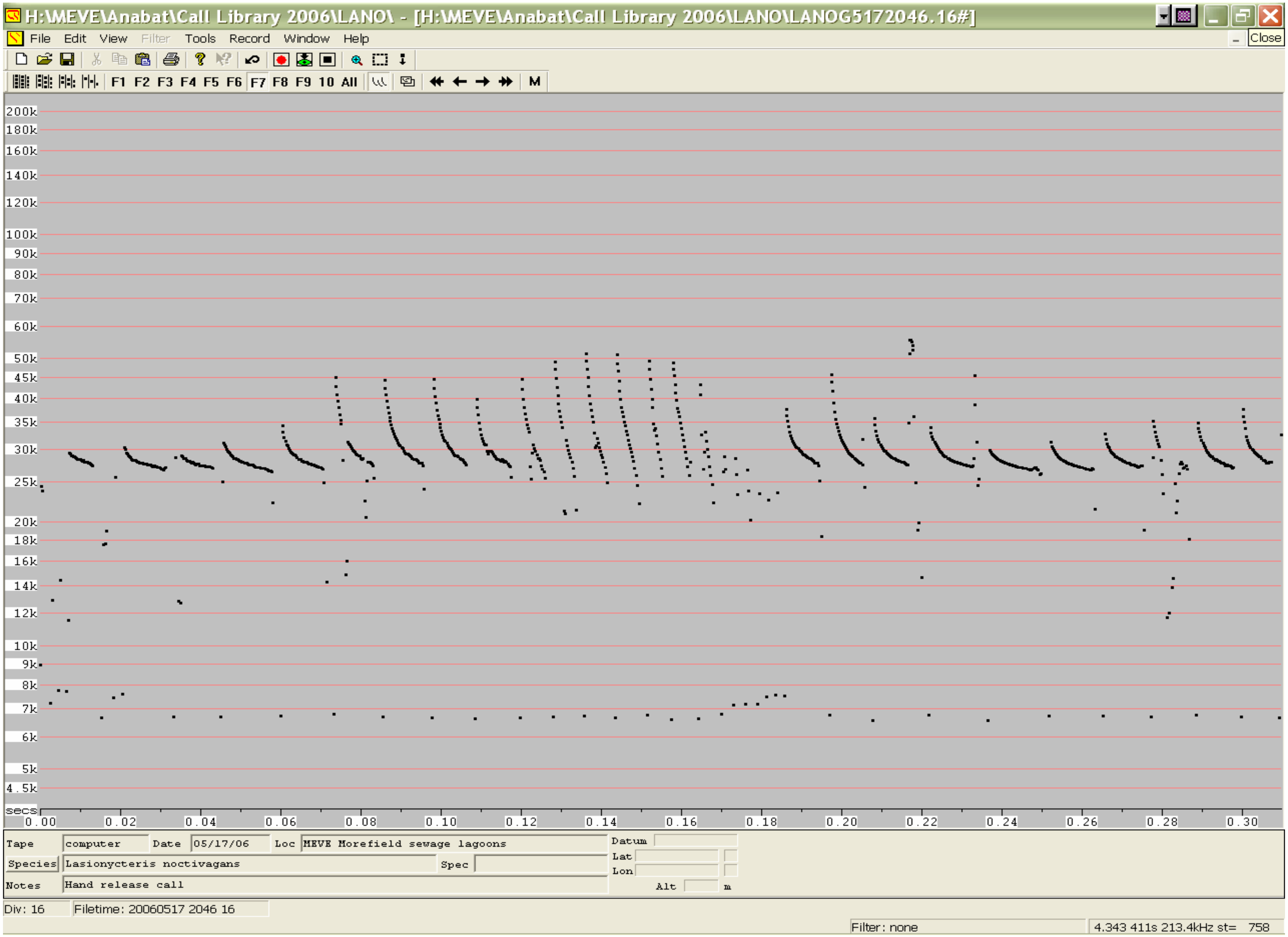
Appendix IV.2. Roosts found by radiotracking bats during 2006 in and around Mesa Verde National Park. Listed by individual bat (Name), species, sex, reproductive condition (Rep: U = unknown, P = pregnant, L = lactating, PL = postlactating), roost number (No.), roost coordinates (UTM X&Y), roost type, precision of location (Prec.: +++ = exact, ++ = within 300 m, and + = general vicinity), distance to roost from initial capture site (Dist. Cap.), and elevation of roost site (Elev.). Distance error is ± 1 km and elevation error is ± 10 m.

Name	Species	Sex	Rep	No.	UTM X	UTM Y	Type	Prec.	Dist. Cap. (km)	Elev. (m)
BRANGELINA	*Euderma maculatum*	F	L	1	725740	4116905	ROCK/CLIFF	++	12	1978
OREO	*Euderma maculatum*	F	L	1	718872	4117304	ROCK/CLIFF	++	9	2032
SCOUT	*Euderma maculatum*	F	P	1	722061	4115834	ROCK/CLIFF	+++	4	1891
BEANO	*Myotis evotis*	F	PL	1	726191	4117630	ROCK/CLIFF	+++	9	1933
				2	726153	4117553	ROCK/CLIFF	+++	9	1929
CENTIE	*Myotis evotis*	F	L	1	720766	4125327	ROCK/CLIFF	+++	1	2288
				2	720768	4125282	ROCK/CLIFF	+++	1	2305
				3	720756	4125260	ROCK/CLIFF	+++	1	2305
				4	720768	4125565	ROCK/CLIFF	+++	1	2305
				5	720784	4125538	ROCK/CLIFF	+++	1	2290
FAITH	*Myotis evotis*	F	L	1	720749	4125325	ROCK/CLIFF	+++	1	2295
				2	721716	4124494	ROCK/CLIFF	+++	1	2223
				3	720775	4125543	ROCK/CLIFF	+++	1	2305
				4	721739	4124491	ROCK/CLIFF	+++	1	2223
				5	720769	4125379	ROCK/CLIFF	+++	1	2290
				6	720791	4125537	ROCK/CLIFF	+++	2	2305
				7	720765	4125490	ROCK/CLIFF	+++	2	2300
FRIDAY	*Myotis evotis*	F	U	?	729072	4140463	UNKNOWN	+	15	2100
FRITO	*Myotis evotis*	F	U	1	727459	4133236	TREE/SNAG	+++	5	2135
				2	727484	4133307	TREE/SNAG	+++	5	2135
				3	727464	4133302	TREE/SNAG	+++	5	2135
				4	727566	4133238	TREE/SNAG	+++	5	2140
				5	727545	4133219	TREE/SNAG	+++	5	2135

Appendix IV.2. (Continued)

Name	Species	Sex	Rep	No.	UTM X	UTM Y	Type	Prec.	Dist. Cap. (km)	Elev. (m)
SUNSHINE	*Myotis evotis*	F	L	1	721149	4124838	ROCK/CLIFF	+++	2	2280
				2	721168	4124831	ROCK/CLIFF	+++	2	2280
				3	721106	4124993	ROCK/CLIFF	+++	2	2280
				4	720970	4130519	ROCK/CLIFF	+++	2	2250
				5	720850	4124517	ROCK/CLIFF	+++	2	2250
				6	720894	4124618	ROCK/CLIFF	+++	2	2250
				7	720785	4124544	ROCK/CLIFF	+++	2	2250
LUCY	*Myotis occultus*	F	P	1	733570	4133774	BUILDING	+++	13	2020
				2	740196	4136458	BUILDING	+++	7	2140
OLIVE	*Myotis occultus*	F	P	1	734536	4132475	BUILDING	+++	7	2020
SKITTLES	*Myotis occultus*	F	P	1	728893	4128553	TREE/SNAG	+++	0	2290
				2	728940	4128336	ROCK/CLIFF	+++	0	2300
				3	734536	4132475	BUILDING	+++	7	2025
WANDA	*Myotis occultus*	F	P	1	734423	4133495	BUILDING	+++	7	2040
				2	734536	4132475	BUILDING	+++	7	2025
EUREKA	*Myotis thysanodes*	F	L	1	725680	4116896	ROCK/CLIFF	+	1	1950
GLINDA	*Myotis volans*	F	L	1	724268	4116076	ROCK/CLIFF	+++	0	2000
MAGIC	*Myotis volans*	F	L	1	724268	4116076	ROCK/CLIFF	+++	0	2000
QTIP	*Myotis volans*	F	P	1	722471	4116331	ROCK/CLIFF	++	3	1960
SPARKLE	*Myotis volans*	F	L	1	721687	4117886	UNKNOWN	+	8	2075
VELMA	*Myotis volans*	F	P	1	724443	4115814	ROCK/CLIFF	++	4	1980
				1	724085	4116961	ROCK/CLIFF	++	3	2080
WENDY	*Myotis volans*	F	P	1	720749	4124943	ROCK/CLIFF	+++	2	2290

Appendix V. Seven hand –released recordings of echolocation calls from six different bat species recorded at Mesa Verde National Park during the summer of 2006. Detailed information about each time-frequency display is at the bottom of the image.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M
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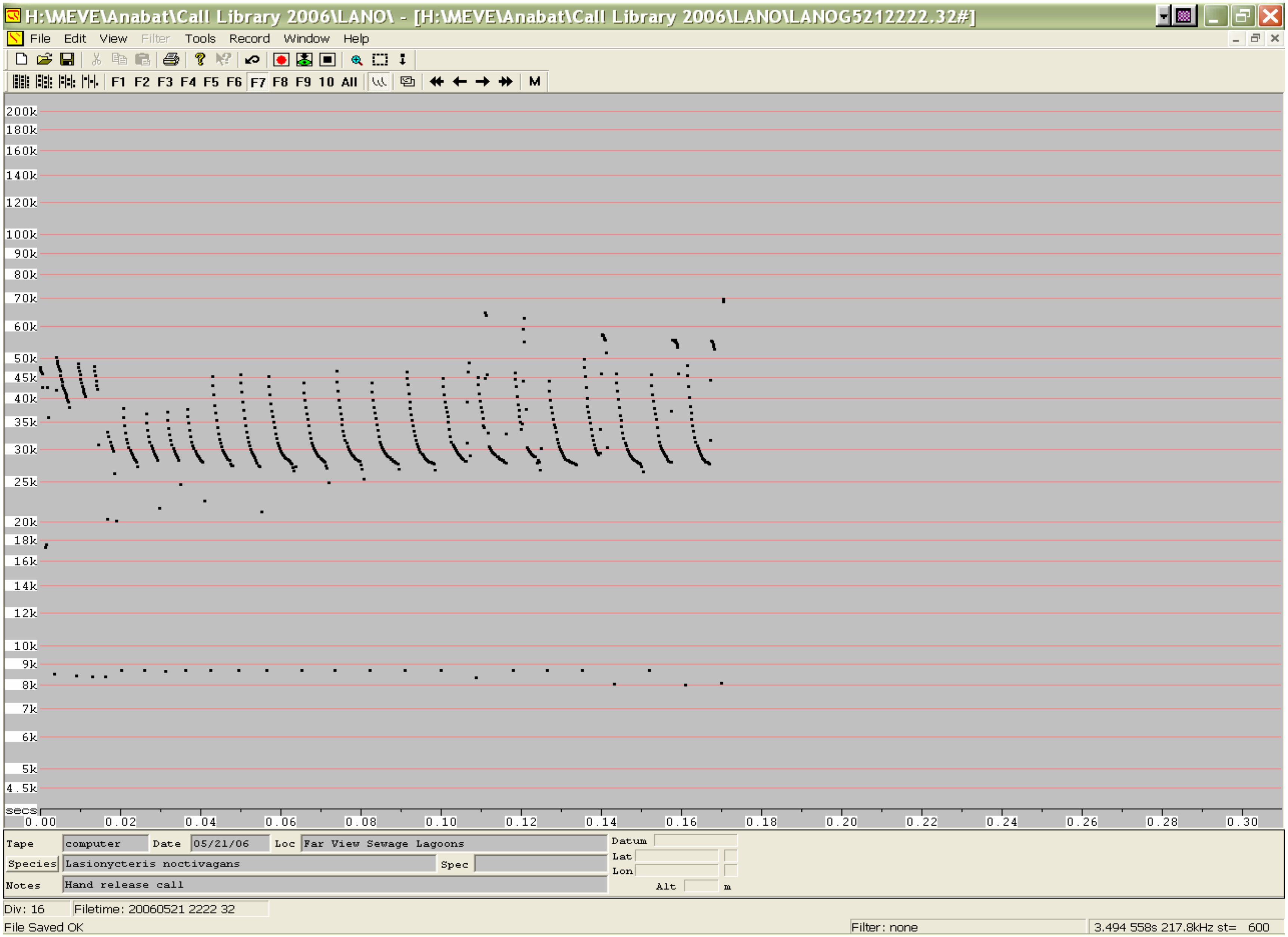
secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer
Date 05/17/06
Loc MEVE Morefield sewage lagoons
Species Lasionycteris noctivagans
Spec
Notes Hand release call
Datum
Lat
Lon
Alt m
Div: 16
Filetime: 20060517 2046 16
Filter: none
4.343 411s 213.4kHz st= 758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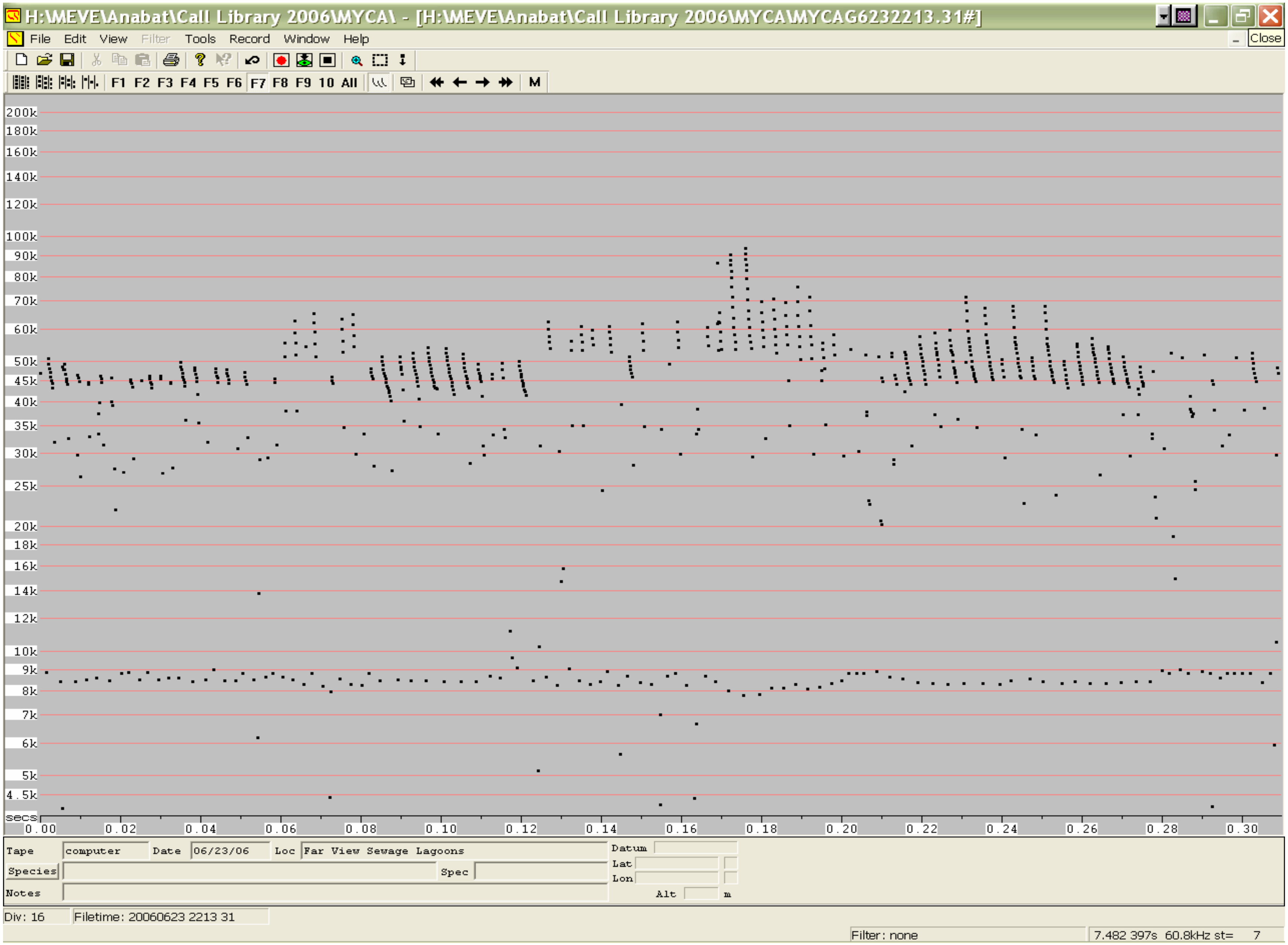
secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer Date 05/21/06 Loc Far View Sewage Lagoons
Species Lasionycteris noctivagans Spec
Notes Hand release call
Datum Lat Lon Alt m
Div: 16 Filetime: 20060521 2222 32
File Saved OK
Filter: none
3.494 558s 217.8kHz st= 600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secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer Date 06/23/06 Loc Far View Sewage Lagoons
Species Spec
Notes
Datum Lat Lon Alt m
Div: 16 Filetime: 20060623 2213 31
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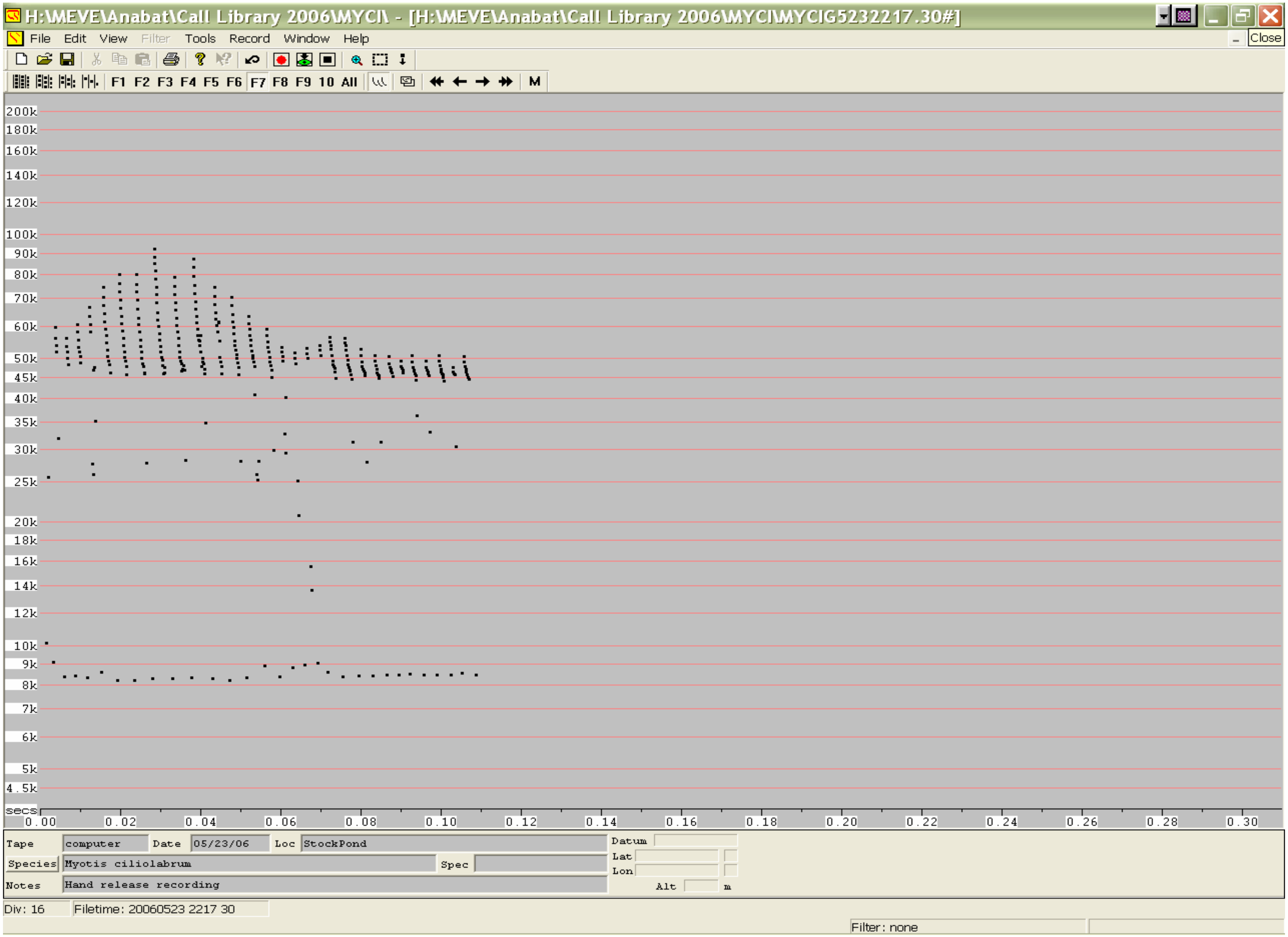
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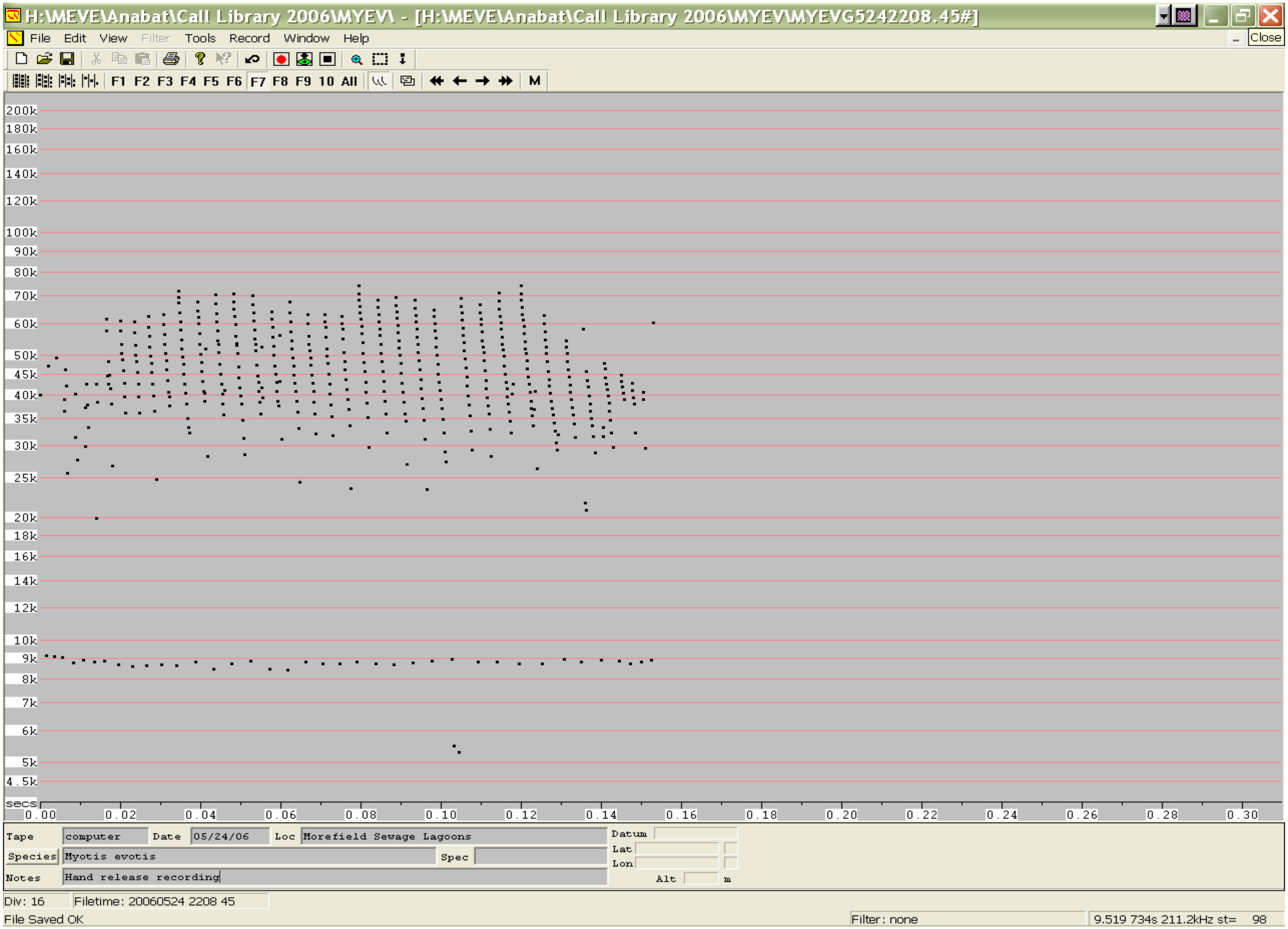
F1 F2 F3 F4 F5 F6 F7 F8 F9 10 All
M
200k 180k 160k 140k 120k 100k 90k 80k 70k 60k 50k 45k 40k 35k 30k 25k 20k 18k 16k 14k 12k 10k 9k 8k 7k 6k 5k 4.5k
secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer Date 05/23/06 Loc StockPond
Species Myotis ciliolabrum Spec
Notes Hand release recording
Datum
Lat
Lon
Alt m
Div: 16 Filetime: 20060523 2217 30
Filter: none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F1 F2 F3 F4 F5 F6 F7 F8 F9 10 All
M
200k
180k
160k
140k
120k
100k
90k
80k
70k
60k
50k
45k
40k
35k
30k
25k
20k
18k
16k
14k
12k
10k
9k
8k
7k
6k
5k
4.5k
secs
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer
Date 05/24/06
Loc Morefield Sewage Lagoons
Datum
Species Myotis evotis
Spec
Lat
Lon
Notes Hand release recording
Alt m
Div: 16
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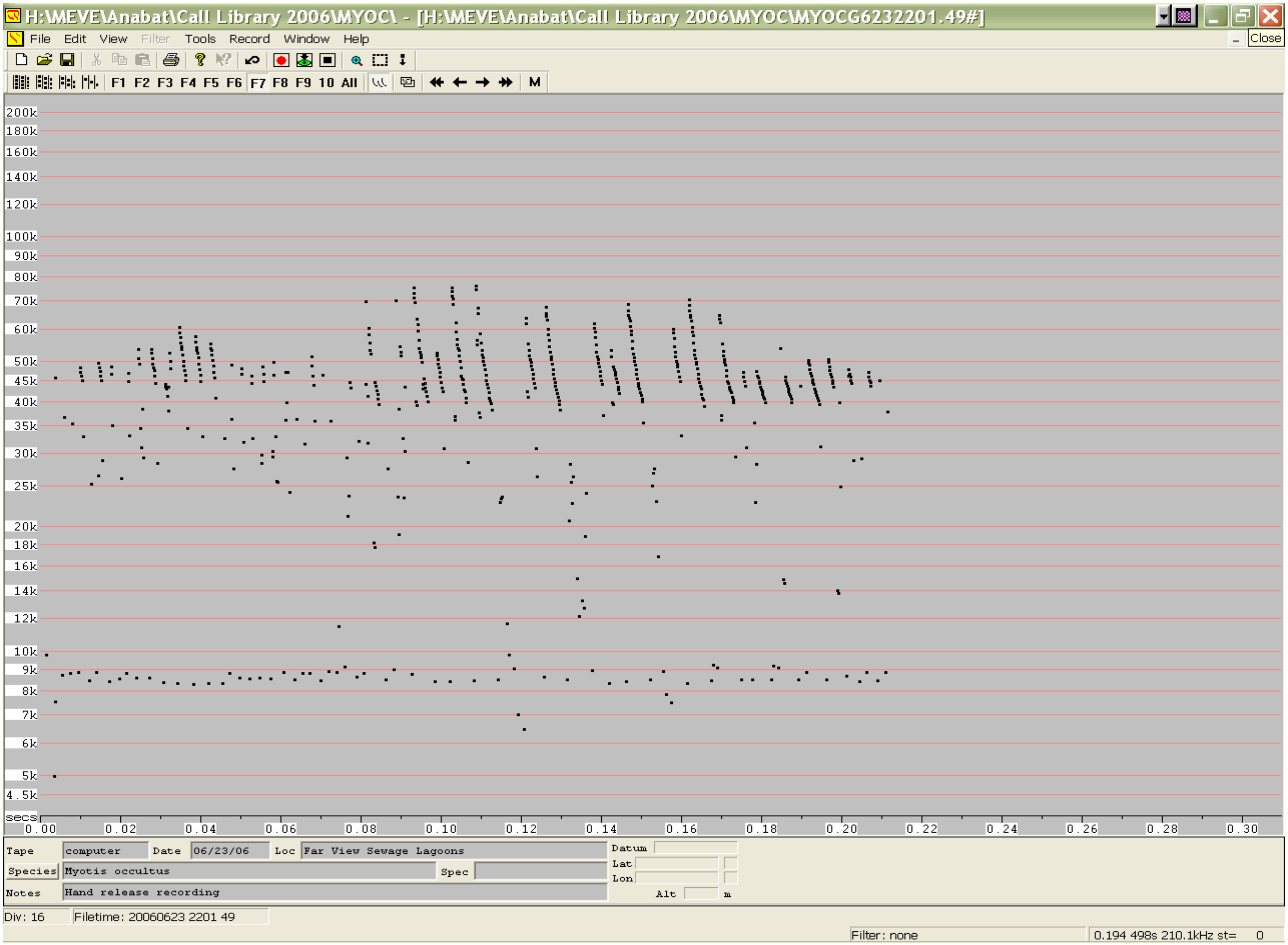
File Saved OK
Filter: none
9.519 734s 211.2kHz st= 98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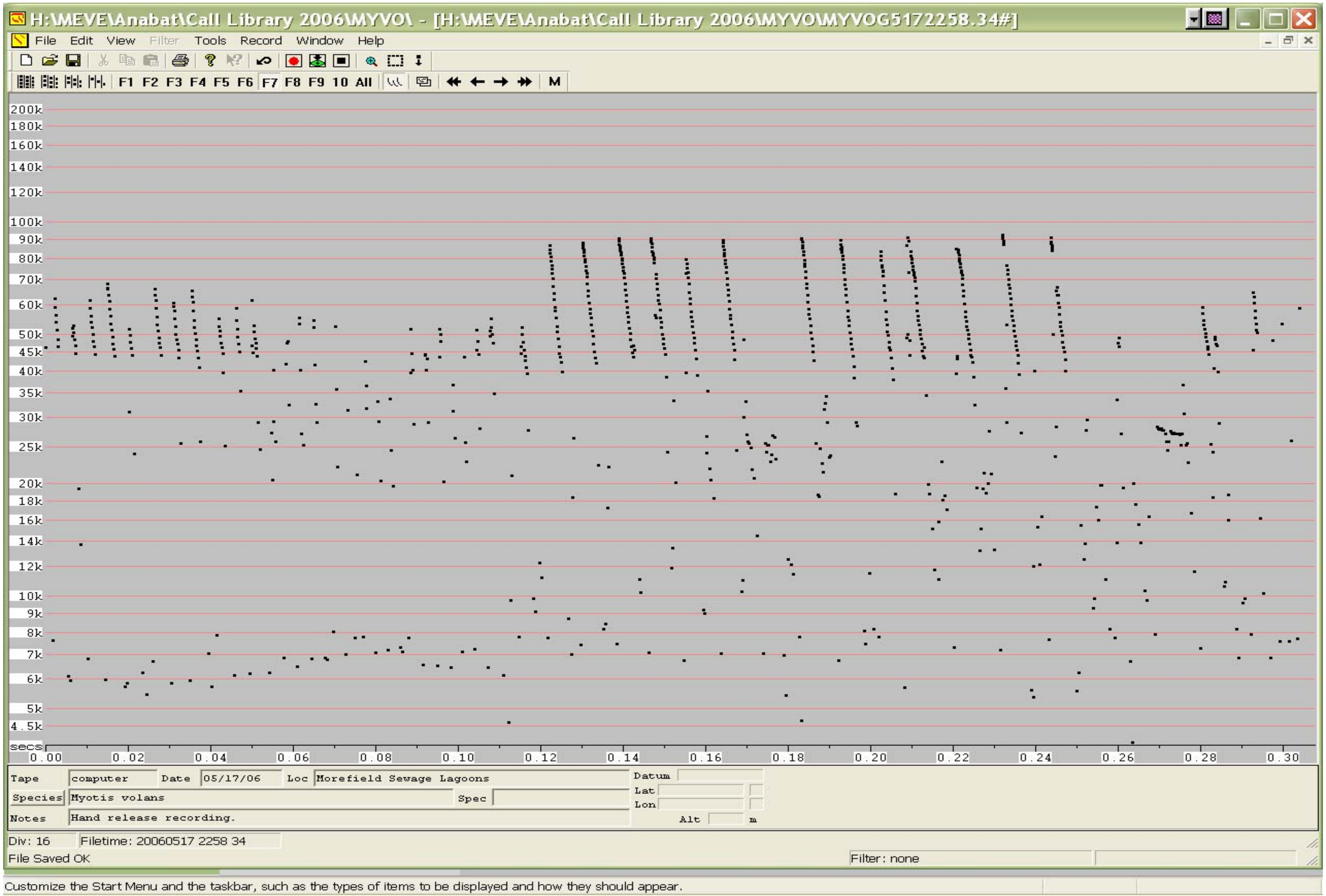
F1 F2 F3 F4 F5 F6 F7 F8 F9 10 All M
200k 180k 160k 140k 120k 100k 90k 80k 70k 60k 50k 45k 40k 35k 30k 25k 20k 18k 16k 14k 12k 10k 9k 8k 7k 6k 5k 4.5k
secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer Date 06/23/06 Loc Far View Sewage Lagoons
Species Myotis occultus Spec
Notes Hand release recording
Datum
Lat
Lon
Alt m
Div: 16 Filetime: 20060623 2201 49
Filter: none
0.194 498s 210.1kHz st= 0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secs 0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20 0.22 0.24 0.26 0.28 0.30
Tape computer Date 05/17/06 Loc Morefield Sewage Lagoons
Species Myotis volans Spec
Notes Hand release recording.
Datum Lat Lon Alt m
Div: 16 Filetime: 20060517 2258 34
File Saved OK
Filter: none
Customize the Start Menu and the taskbar, such as the types of items to be displayed and how they should appear.